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EDITED BY T. C. MARTIN AND W. D. WEAVER.

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PHILADELPHIA OFFICE - - - - - - 929 Chestnut Street.
EUROPEAN OFFICE, Hastings House, Norfolk St., Strand, London, Eng.

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ELECTRICAL WORLD AND ENGINEER.

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"BACK TO THE PINE KNOT."

The philosophy of Charles Wagner's "Simple Life" has attracted a good deal of attention in this country ever since President Roosevelt commended the charming little book in which the Alsatian clergyman expatiated on the virtue and happiness of everything that in ordinary literary parlance is supposed to be abhorrent to "Alsatia" and its ribald crew. Since the book was written and while it was being read, Mr. Wagner has visited this country to raise money so that his flock may worship more luxuriously in a richer temple, and having given this evidence of his sincerity as well as having achieved his excellent purpose, he has gone home. His arrival was heralded with "alarums" at Washington and his departure was accompanied by endless newspaper articles, all going to show that while we wanted the "simple life" for ourselves we rather grudged it to him.

The New York *Sun*, in an epigrammatic discussion of the subject, raises the question whether, after all, the "simple life" can be "consonant with the electric and electric light age." Just what electricity has got to do with it, is rather difficult of discovery. Our own idea has been that if electricity did anything it made for simplicity, for direct methods, ten-word telegraph messages, 15-mile car rides for the masses at 5 cents, cheap telephony for the farmers, cleanly economic power in factories, and things of that kind. The *Sun* critic has apparently been dazzled by the advertising effect of a few electric light signs on upper Broadway, and from that has reasoned in a muddled way that electricity is a synonym for, and a begetter of, frenzied luxury. In the same manner untraveled Americans when they first note the glitter of the Parisian boulevards, think hastily that all Frenchmen and women are gaudy, frivolous, trivial butterflies and moths around the flame—like themselves—and forget or do not see, the sound, sane, serene, laborious race back and beyond it all that has made and will ever make France great. We would suggest that the *Sun* critic be kind enough to revise his ideas about electricity. It may breed dollars, but the habits and ideas it encourages are as simple as those of Mr. Rockefeller making merry over a plain cracker, or Mr. Andrew Carnegie sending his exhilarated banquet guests home at 10.30 p.m. In its essence and meaning electricity is a sheer boon to the millions of mankind, and has nothing to do with such waste and luxury as were wildest in the old days that knew not the great modern agency of light, heat, power and intelligence.

ELECTRIC VS. STEAM TRACTION.

We are glad to be able to publish, in the form of a letter, a supplement to Mr. J. G. White's valuable Congress paper dealing with the use of electricity in larger railway work. His attitude is that of open-minded conservatism, and fairly represents, we think, the views of many well-informed engineers. General statements on such a topic are particularly liable to misinterpretation, and it is clear enough that for the present at least each case must be considered by itself as a problem in details. One point which Mr. White emphasizes with justice is the overmuch importance sometimes attributed to the possible return of energy to the line on electric roads. The possibility of a material saving by this procedure has been evident from the early days of electric traction, but in actual practice, for one reason or another, very little has been done toward realizing this saving. If important improvements in this direction can be made we certainly hope that they will soon be forthcoming.

Alternating-current apparatus seems to have particular advantages for such purpose, and when alternating-current roads become fairly common, data on energy return will doubtless be copious. Mr. White's chief point of difference with Mr. Stillwell is really the applicability of alternating motors to larger railway service. Mr. White gives, unfortunately, in less detail than would be desirable, the result of his study of a proposed interurban road in which the saving in operating expenses worked out as only 3 per cent. of the total in favor of alternating-current working. This figure seems low in view of similar investigations and deserves further examination. Local conditions may influence such results very greatly and unless the figures are given *in extenso* it is rather hard to form a clear idea of the merits of the case.

We have been squarely on record as believing in the possibility of alternating-current traction for some years, on the broad ground that the key to economy in large electric railway service is the raising of the voltage on the working conductor and feeders. The present sub-station system does not meet the requirements of economy in distribution to anything like the extent that is desirable. We want to see alternating-current traction worked for its full value and we believe that it is going to succeed. But to many its actual status has been rendered ambiguous through the kaleidoscopic changes of attitude which have characterized recent discussion of electric traction. Leaving aside sudden changes of front as to the merits of particular alternating-current systems, there also appears to exist a reluctance to bring about at the present time a direct issue between direct and alternating-current traction, and the inconsistencies to which such a situation necessarily gives rise are naturally perplexing to the inquiring mind. In our recent comment on the New York Central operations we called attention to the fact that the reasons adduced for the choice of direct-current apparatus for that work were mainly reasons which applied *a fortiori* to street railway work. The validity of such reasons does not necessarily involve the validity of the final conclusion, and we would fain know the real attitude of the front rank of electric railway engineers upon the subject. American engineers have devoted much time and skill to the evolution of alternating-current railway motors, and now that they have brought them to commercial development, what is their frank and mature judgment concerning them? When a given course of action is cordially endorsed in the abstract and damned with faint praise in the concrete, the unprejudiced observer is quite at sea for conclusions. We invite discussion of the subject from all who are in a position to throw light upon it, for in the conference of many is wisdom. We have long championed alternating-current traction and of late we have been greatly gratified at the enthusiasm and skill with which it has been taken up. The published tests of the new single-phase motors are such as to be most encouraging to the friends of the system, but when an actual road comes up for equipment somebody generally shows up with a large wet blanket like that with which Mr. White enfolded his interurban line. If this attitude is merely the result of overconservatism, which is not unknown in the engineering fraternity, we trust that it will be soon changed. One of several alternating-current roads are due to start commercial operations in the very near future, and we hope that all the engineers who have figured such roads off the map will be on hand to watch the results ready for a prompt change of heart.

PRACTICAL RESULTS WITH LOADED TELEPHONE LINES.

Among the many interesting papers which were read before the International Electrical Congress of St. Louis and which are due to appear in its *Transactions* now in course of being printed, was a paper by Dr. Hammond V. Hayes on the practical results obtained from telephone lines, artificially loaded in accordance with the general plan of the Pupin patented system. Not only are the data given in this paper the first that have been published by an acknowledged expert and trained technologist, but they also throw light upon a number of points in the theory of telephony that have heretofore remained obscure. The paper points out that lines loaded in such a manner as to make 7,000 inductance coils struck per second by the telephone current waves, give satisfactory conversation; or, in other words, that the articulation of transmitted speech is not appreciably impaired by this spacing of the loads. This is an important fact, because theory shows that a loaded telephone cable is virtually a frequency sieve. It is a complete barrier, or non-conductor, for waves whose length is less than π coils per wave; while for waves of lengths including 4 or more coils, the cable offers practically no more impedance than if the added inductance were smoothly distributed. Looked at in another way, waves that include 4 or more load coils in their length, will be transmitted practically as well as though the inductance were uniformly distributed; but waves that include less than three coils in their length will be disrupted and reflected back by the loaded underground cable. Consequently, when advancing waves strike 7,000 coils per second, and telephonic conversation is unimpaired, it is evident that all waves essential to the commercial transmission of speech have a frequency lower than 2,228 cycles per second. We may safely say, therefore, that good telephone transmission will be secured if the frequencies of vocal utterance between 100 and 2,000 cycles per second are fairly transmitted without unequal attenuation, although frequencies much higher than 2,000 cycles per second are stated to be present in the sounds of speech.

The paper also gives curves showing the relative strengths of telephone currents received over different lengths of loaded and unloaded circuit. These curves convey much information, and are of great interest and value. They are stated to have been drawn from actual tests on commercial circuits and are, therefore, to be assumed as representing observation, and not theory, such observations being conducted by comparing the loudness of sounds in receiving telephones on different circuits. The curve which is given as representing the behavior of unloaded telephone cables of the standard underground type is nearly a simple logarithmic curve. This underground cable offers about 96 ohms per loop-mile, and has about 0.068 microfarad per loop-mile. The attenuation constant of this curve is approximately —0.0557 to the base 10; so that the logarithm of the fraction representing the current received over a given number of miles is obtained by multiplying the miles by this constant. At forty miles, for example, the logarithm would be —2.228, corresponding to the fraction 1/190.6, or 0.525 per cent.; so that the current received over this line is only about one-half of one per cent. of the current that would be received on short-circuit, or close to the transmitter. Forty miles of such unloaded underground circuit loop is, perhaps, the ordinary commercial limit of telephone transmission. Some place the limit as low as 30 miles and others as high as 45.

If we compute, by telephonic theory, the frequency of alternating current for which this attenuation rate is developed over an unloaded circuit of the constants named, the result appears to be almost precisely 800 cycles per second, corresponding approximately to the note *G*, at the top of the treble clef. Consequently, it would seem that an underground telephone cable, when operated in practical conversation at all frequencies between 100 and 2,000 cycles per second, behaves, in regard to attenuation, virtually as though it were operated at the single frequency of 800 cycles per second, which is not very far below the mean between the extremes just given. With this rule as a guide, it is possible to compute the attenuation and the receiving end impedance of any unloaded telephone cable using

standard terminal apparatus. For instance, the receiving end impedance of the forty-mile underground cable, here assumed as the commercial limit for unloaded standard cable, is about 40,000 ohms; so that if the alternating e.m.f. at the transmitter is, say, 4 volts during speech, the received current is one-tenth of a milliampere. This would then be the limiting amplitude of telephonic current for the satisfactory reproduction of speech in the standard telephone of to-day.

When the same type of underground cable is loaded to the extent of 0.6 henry per loop-mile, using terminal tapers to reduce the losses by reflection at the ends of the circuit, the curve given in the paper shows that the attenuation constant is reduced to —0.0115, or to about one-fifth of its original value before loading. There is, however, a constant loss at terminals, in spite of the taper, amounting to about 16 miles of loaded cable. Consequently, the range of practical transmission has been increased by the loading from say 40 miles to $40 \times 5 - 16$, or 184 miles—that is, about 4½ times. With long overhead telephone lines the gain in range by loading thus far obtained does not appear to be so great as with cables, owing to the fact, as pointed out in the paper, that whereas underground cables have negligibly small inductance, and are, therefore, radically altered by loading, overhead wires naturally possess some inductance and are consequently only improved in degree by loading. The range of transmission over such wires is shown by the curves to be increased by loading to 2 or 3¼ times, according to circumstances.

EDUCATIONAL CONSOLIDATION.

If newspaper reports are to be credited the proposed concord between Harvard and the Massachusetts Institute of Technology is at least in the latter stages of discussion. Every few days there is a report that an agreement has been tentatively reached, followed always within forty-eight hours by a perfervid denial. We have already expressed ourselves regarding the feasibility of some sort of *modus vivendi* that would be highly useful to both institutions, but current rumor does not rest satisfied with this and proclaims on the one hand virtual consolidation and on the other failure of the negotiations. That access of the combined resources of both institutions would be advantageous to the student is a proposition that scarcely needs argument, and that both institutions would be glad to see it brought about if practicable is equally obvious. The moot point is whether the gain necessitates or is worth any material sacrifice of autonomy, and whether frank and friendly competition would not be preferable to such a sacrifice. We had no brief for either side, but the matter is important as bearing on policies in technical education which in itself concerns us very keenly. The present situation is about as follows: The Institute of Technology, which is in the very front rank of the world's engineering schools, has been for some years crowded with students up to about the limits of its resources. It is working overtime, so to speak, in most of its departments, and has reached the point where it cannot materially increase its output without increasing its plant and its working force. Harvard on its part has the Lawrence Scientific School, which is doing admirable work in engineering studies, and while not forced to the highest pressure like "Tech" still has about all the students it can comfortably care for without overrunning its resources as they now are.

Now, if things do not go amiss, Harvard will have available in a few years a large endowment for applied science. The scope of the work which was intended to be accomplished by its late benefactor is perhaps a little obscure and we will not attempt here to pass upon it. But when the funds become available Harvard will have the choice substantially between adding greatly to the resources of the present school and attempting work of an essentially different scope. Now, at present Harvard and "Tech" cannot be regarded as active competitors in engineering education. This involves no comparison of the work done, but is merely a statement of fact. When there exists no visible tendency for students to drift away from one toward the other it is clear that each institution is filling a want and doing it well. If the plant and staff of the Lawrence School were double what it is, we believe it would be well filled without drawing a perceptible number of students away from "Tech." The demand for technical education is on the increase faster than the resources of the institutions that supply it. If, on the other hand, Harvard were to come into the field with a technical school of different scope and aims from the Lawrence School, such a school might either compete with "Tech" or in one way or another supplement it. Of the two courses the latter would certainly be of greater benefit to the cause of technical education, and unless we greatly mistake the temper of Harvard University it would never sacrifice public usefulness to needless rivalry. Institutions of learning are not commercial enterprises, and even when they combine their union is not like the union of competing factories. There is even grave doubt whether any material saving could be made by uniting two hard-worked schools. After a certain point increase of plant and force has to be very nearly proportional to increase of students, and even the administrative costs increase in nearly the same ratio. In fact, there is sometimes a tendency away from economy with increased numbers, since courses interlace and the available hours for work interfere and require subdivision of instruction. There is nothing comparable with the selling costs of factories or the economy of working capital, to give a chance of saving by consolidation.

On the face of the facts, therefore, the gains by any organic union over and above those which could perfectly well be secured without such union would not be important. As we understand the recent reports, however, there is another phase of the matter which has assumed some importance. Granted that Harvard under the McKay endowment, is charged with operating a school of rigidly practical applied science, is it wiser in view of her aims and scholastic traditions to operate it directly and single-handed or to call upon a colleague long experienced in practical technics to act as the working conservator of her trust? This is a question entirely different from organic union and of far broader educational significance. It is easy to see how the results might be of far-reaching importance in technical training and how the work of each institution might be made to supplement that of the other without merging the identity of the two at all either now or hereafter. The mere existence of a joint board to oversee the administration of the trust would not imply the benevolent assimilation of "Tech" by Harvard any more than its similar guidance of a foundation originally controlled by the latter would make Harvard the Liberal Arts department of the former. We should be sorry to see either "Tech" or the Lawrence Scientific School lose identity in a general merger, for both institutions have honorable pride in their achievements and traditions well worth preserving. As regards Harvard University proper, its methods and aims are so distinct from those of a purely technical school that a merger seems needless when harmonious co-operation is possible. Very little that is definite has yet transpired with respect to the proposals now being made in the conference between Harvard and "Tech," so that no intelligent discussion of actual details is possible. But we feel sure that no settlement to the material disadvantage of the substance or sentiment of either of them can successfully run the gauntlet of the respective bodies of alumni. In the long run these constitute the *de facto* governments of the institutions and will make their power felt for good. But whatever can be gained by cordial co-operation will certainly help on the cause of education, which, rather than the accumulation of endowments or the aggregation of numbers, is the real function of institutions of learning.

Meeting of American Society of Mechanical Engineers.

Of the eighteen papers on the programme of the 50th meeting of the American Society of Mechanical Engineers, held in New York, December 6 to 9, none bear directly on electrical engineering. An interesting paper to many electrical engineers, however, is one contributed by Mr. George I. Rockwood entitled "Condensers for Steam Turbines." The type of condenser described is the injection or ejector condenser and relates to the application of this apparatus to a 400-kw Westinghouse-Parsons plant installed in the Atlantic Mills of Providence, R. I., whereby a vacuum of 28 to 28½ in. is maintained. The exhaust steam is led through 20 ft. of vertical 18-in. cast-iron pipe and three short-turn elbows into a 16-in. Bulkley injection condenser. The injection water is drawn through 500 ft. of pipe under a head of about 3 ft. A 6-in. belt-driven Lawrence centrifugal pump elevates the water into a vertical tank 30 in. by 15 ft. deep. From near the bottom of the tank a 7-in. injection pipe rises up to the condenser. Owing to the water being taken from the bottom of the tank, none of the air coming along with the water pumped into the top of the tank passes over into the condenser. The present load on the turbine unit is from 300 to 350 kw and with this the 7-in. injection valve is open only a few turns and the temperature of the hot well is 80° to 90°. The highest degree of vacuum thus far reported, as measured in the turbine exhaust chamber, is 28¾ in. and the lowest 27½ in., the variation being caused partly by changes in the barometer, but more by variable leakages in drop valve speeds and possibly by a variable amount of air entrained by the injection water. It takes 10 hp to supply water by means of the centrifugal pump in sufficient quantity to condense 400 kw of steam.

Mr. Rockwood states that the method of sealing the shaft of the Parsons turbine against air leak, where it passes out to its journals from the low-pressure chambers, which is by pumping water with centrifugal pumps formed in small recesses in the shaft cover, thereby keeping a water pressure in these recesses in excess of that of the atmosphere, has proved a perfect success. The injector condenser costs, fully installed with centrifugal circulating pump, tank piping and valves, from $2 to $2.50 per kw. This cost is much reduced if there is a natural head of water available. In the installation described the piping and automatic relief valve cost $591.50. It is stated that the several types of surface condensing systems cost from $7 to $10 per kw, and that jet condenser systems cost from $5 to $6 per kw. Mr. Rockwood stated that the absence of cylinder oil in the case of turbines is sufficient to determine the purchase of this apparatus in place of engines for power where boiler water is used for washing, as in a dye house.

Mr. A. Bement, in a paper entitled "More Exact Methods for Determining the Efficiency of Steam Generating Apparatus," suggested that if boilers are to be compared with each other they should be supplied with the same relative quantity of heat at the same temperature, for the reason that the performance of a boiler is influenced by the temperature at which the heat is supplied, and also that the absorption is less complete with a large quantity of heat passing than with a smaller quantity. He suggests using a standard high-grade coal and a standard pressure, which need not be that which would be employed in service. He considers it would probably be better to produce a uniform capacity as measured in equivalent pounds of water evaporated from and at 22° per square foot of heating surface per hour, or in other words operate the boiler at its rated horse-power capacity. With these standard conditions of developed capacity, initial temperature and steam pressure, the heat developed referred to the heat absorbed will show the efficiency of the boiler, so that comparisons may be made.

Mr. C. A. Sargent contributed a paper entitled "An Indicating Steam Meter," in which he described a meter based upon the assumption that since the product of pressure and volume is a constant, we can determine the amount of steam passing from one receptacle to another if we know the difference of pressure in the two receptacles, by determining the area of the opening through which the steam flows; but as the weight of steam passing through a definite opening will vary with the pressure and the difference in pressure each side of the opening, we must vary the opening with the pressure if a uniform weight is flowing through. In the meter described, with a constant weight of "horse-power" passing through, the pointer will follow the horse-power curve on the dial, though the pressure of steam varies between the limits of the meter. It is stated that in the meter described all the moving parts are protected from derangement caused by inertia of water passing through the openings. The description refers to a two-inch meter which is calibrated to show the horse-power (based on 30 pounds of steam per horse-power-hour) passing through with a steam pressure between 50 and 100 pounds.

Mr. S. H. Bunnell, in an article entitled "The Power Plant of the Tall Office Building," gave a comparison between compound and four-valve simple engines running non-condensing. The conclusion is that the four-valve simple engines running non-condensing give very much better steam distribution and economy than the compound engines referred to in the comparison. The re-evaporation due to expansion even at light loads is not great and does not indicate any such loss of efficiency as is due to the large gaps of the compound diagrams. The first mentioned engine has a far greater range of capacity with reasonable economy than the non-condensing compound engine, and Mr. Bunnell considers that for the actual conditions of service in power plants of large buildings, it is much to be preferred.

Mr. F. W. Dean contributed a paper on "Forcing Capacity of Fire Tube Boilers," designed to correct a widespread impression that the fire tube type of boiler has less capacity to be worked above its rated power than boilers of the water tube type. In support of this position particulars are given of several boiler tests upon different kinds of fire tube boilers. The details of tests are given of two horizontal return tubular boilers, two Manning vertical boilers, a Corliss vertical boiler and a "gunboat" boiler. The final conclusions of the article are that the data presented offer ample reasons for believing that the fire tube type of boiler is fully equal to any demand that may be made upon it, and that there is no evidence that the water tube type of boiler can surpass it in forcing capacity.

An interesting paper was contributed by Mr. James B. Stanwood entitled "Losses in Non-condensing Engines," which subject he considers under the heads of cylinder efficiency, losses, the expansion factor, the condensation factor, the effect of clearance, the effect of compression and release and the effect of varying loads. These various factors are discussed and means for their determination pointed out.

Marconi Wireless and the Government.

There has recently been correspondence between the Bureau of Equipment of the Navy Department at Washington and John D. Oppe, general manager of the Marconi Wireless Telegraph Company of America, in regard to the business of reporting steamships from Nantucket. Since the privilege of using its own apparatus for that purpose on the Nantucket Shoals Lightship was withdrawn, several months ago, the transatlantic steamships which are equipped with Marconi apparatus have been placed at a disadvantage. To meet that difficulty two changes have been made—the instruments on the vessels have been altered so as to give them a longer range, and the equipment of the land station at Siasconset has been strengthened correspondingly. It is now possible to cover the distance easily without resort to the intermediate floating station, forty miles or so off shore.

In a letter dated November 28 Mr. Oppe acknowledges one from the Bureau of Equipment informing him that the installation made under government auspices on the lightship is at the disposal of shipping. Mr. Oppe then politely points out that these facilities are needless, since the vessels can now communicate directly with Siasconset, as they all use the Marconi system. He then protests against the conduct of a rival service by the Government. The Marconi Company has equipped its station at great expense, and does not view competition with favor. It believes that its own long experience with such work enables the Marconi Company to perform the work in question more efficiently than can the Government, which has only recently come into the field. Intercommunication between ships having Marconi instruments with stations equipped with other apparatus, it is asserted, cannot be carried on without a sacrifice of scope and utility. Furthermore, Mr. Oppe has reason to believe that the Arco-Slaby equipment now on the lightship infringes the Marconi patents, and he is advised that to exchange messages therewith would prejudice the interests of the Marconi Company before the courts. Finally, the argument is advanced that the maritime interests of the world demand unity in the system employed by ships and at land stations.

Niagara Power in Buffalo.—II.

THE COMBINED LOADS.

ENERGY transmitted from Niagara Falls operates motor-generators and rotary converters of 8,485 hp capacity for the Buffalo General Electric Company and rotary converters of 10,000 hp capacity for the International Railway Company, in Buffalo, besides the 18,642 incandescent lamps and the motors of 18,124 hp on the premises of consumers that are supplied directly by the Cataract Power & Conduit Company.

This aggregate load of more than 38,000 hp is all supplied with current through the transformers of 27,000 hp total capacity that reduce the transmission voltage of 22,000 to 11,000, at the terminal house of the Cataract Company.

Ability of this group of step-down transformers to carry all three of these loads during one-half of each year is due to the fact that the maximum demands of all do not come at the same time, and to the use of storage batteries in the systems of the Buffalo General Electric Company, and of the railway company. The Cataract Company and the General Electric Company use only the Niagara power at all times of year, but the railway company operates its steam power stations in Buffalo from 6 a.m. until midnight daily, from October first to May first in each year. At times of maximum load during the winter months the steam stations supply more than 5,000 hp and the storage batteries nearly 4,000 hp to the railway system at Buffalo. Between May first and October first the storage batteries of the railway system at Buffalo supply about 3,700 hp at maximum load, and these batteries are charged with the transmitted water power.

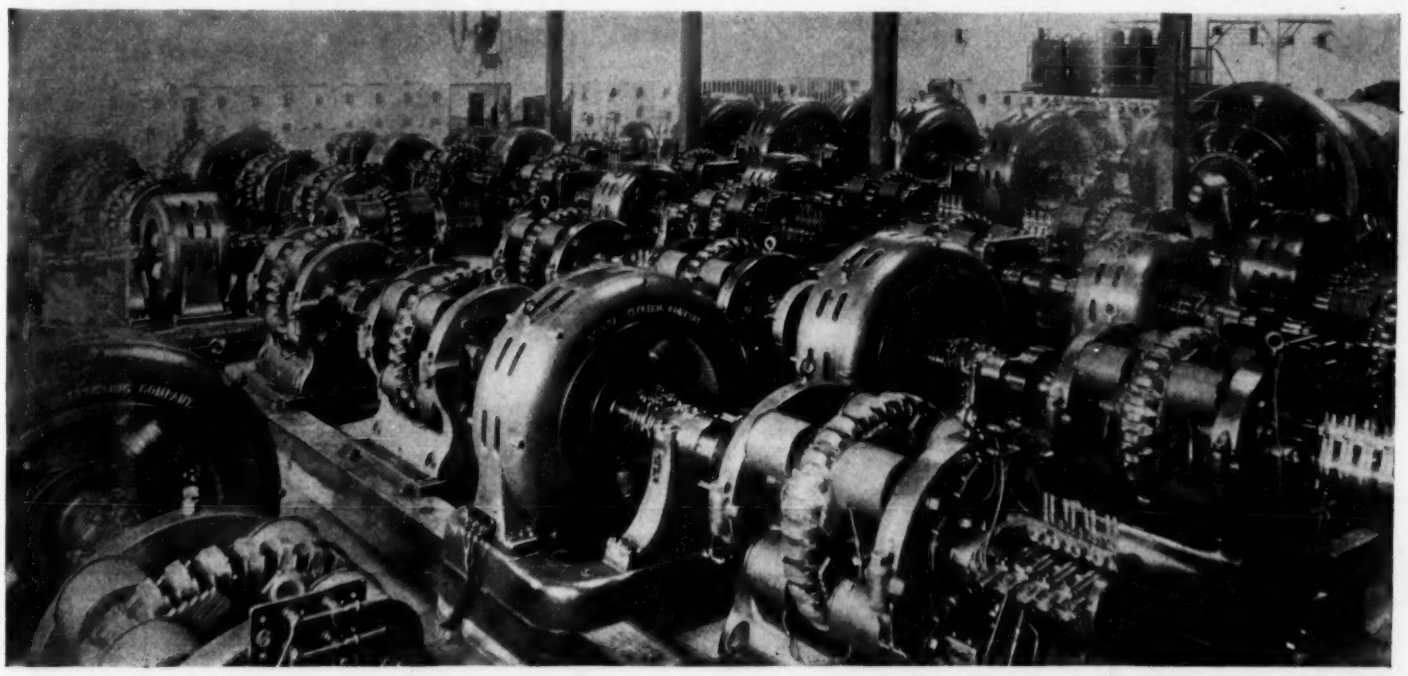


FIG. 1.—POWER HOUSE OF THE BUFFALO GENERAL ELECTRIC COMPANY.

As may be seen from the above, the load curve of the Cataract Company for any day between May first and October first includes the loads on the General Electric and the railway system, modified by the charge and discharge of the storage batteries. In the curve presented of the full load of the Cataract Company for the 24 hours of June 18, 1904, the minimum load is about 6,100 hp at 5 a.m., and the maximum point is about 17,300 hp at 8.45 p.m. The resulting ratio of 35.2 per cent. for the relation of the least and greatest load on the system for the day is enough to indicate unusual conditions, but the feature of most interest is the cause of the curve during the ordinary working hours. At 7.30 a.m. the load was about 15,100 hp, and it did not drop as low as 13,100 hp until 5.45 p.m., save between 11.45 and 1 at noon. This portion of the curve shows at a glance that transmitted water power has captured a large share of the factory load at Buffalo. Barring 1¼ hours at noon, the load from 7.30 a.m. down to 6 p.m. ranged between 75.7 per cent. and 87.3 per cent. of the maximum load for the 24 hours.

The load curve of the Buffalo General Electric Company for the 24 hours of July 20, 1904, in which battery discharge is not distinguished from the power supplied directly by the transmission system, illustrates the usual case of a great lighting system with a fair motor load. Such a curve is to be expected for the load of this company, which does all the electric lighting of the city except in the cases of the relatively few large consumers that are supplied directly by the Cataract Company. This curve reaches its maximum of 5,555 hp at 8.30 p.m., and its minimum of about 875 hp runs from 5.30 to 6 a.m. From 7.30 a.m. to 6 p.m. the curve ranges between 1,200 and 2,000 hp, the latter being 34 per cent. of the maximum load at 8.30 p.m. The ratio of minimum to maximum load is 15.7 per cent. In the curve of total load there is included series arc, 500-volt power and 2,200-volt, 60-cycle alternating service. The 500-volt power load extends from 7 a.m. to 6 p.m., and has a maximum of about 700, or a little more than one-third of the day load. There is also a small 500-volt power load from 7 p.m. until midnight.

On the International Railway system at Buffalo, on June 29, 1904, the minimum load, including the charging of storage batteries, was 1,667 hp between 4 and 5 a.m., and the maximum was 9,500 hp at 6 p.m. Of this peak load 3,752 hp was carried by the Buffalo storage battery, and about 5,700 hp by the electric transmission from Niagara Falls. During the 24 hours the minimum demand on the transmission system by the railway was 1,667 hp, the entire load at times between 4 and 5 a.m., and the maximum demand was 6,114 hp at 6.20 p.m. From 6.20 a.m. to 11 p.m. the load of the railway at Buffalo on the Niagara transmission varied between 4,900 and the maximum of 6,114 just stated. The railway thus uses a fairly uniform block of power during about 17 hours per day.

As the three curves just considered relate to days that were only about one month apart, they indicate approximately the way in which the load on the Niagara transmission is made up. At 5 a.m., the time of minimum load on the system of the Cataract Company, its 6,100 hp was apparently made up of about 950 hp on the lines of the Buffalo General Electric Company, 2,050 hp absorbed by the Buffalo railway, and 3,100 hp divided among its own private consumers. When the demand was greatest on the Cataract system, at 8.45 p.m., its load of 17,300 hp consisted of about 5,500 hp for the Buffalo General Electric Company, 5,200 hp in use by the Buffalo section of the International Railway, and 6,600 hp for the large private industries that operate with the transmitted water power.

Through the long working hours of each day, from 7 a.m. to 6 p.m., when more than one-half of all the energy transmitted from Niagara Falls to Buffalo is consumed, the average load of about 14,500 hp on the Cataract system is made up of nearly 1,900 hp distributed by the Buffalo General Electric Company, and about 5,300 hp used to operate the railway, leaving 7,300 hp for the industrial plants. Besides this a part of the energy distributed by the Buffalo General Electric Company is used to operate factories. The important conclusion from these comparisons of load curves is that not more than

one-half of the Niagara power that comes to Buffalo during the summer months is required to operate the commercial lighting and railway systems there, and that fully one-half is consumed by large factory and industrial plants.

On December 18, 1903, the minimum demand on the Cataract system, as shown by its load curve, was 7,300 hp, at 3.30 a.m., and the maximum demand was 23,300 hp at 5.15 p.m., so that the minimum was 31.3 per cent. of the maximum power. Between 7.30 a.m. and 10.30 p.m. the general range of the load, save at noon, was above 17,000 hp, or 73 per cent. of the maximum. At noon the load dropped momentarily as low as 11,300 hp. For the same day the load curve of the Buffalo General Electric Company reached its lowest point at 1,850 hp between 11.30 a.m. and noon, and its highest value of about 7,600 hp at 5.30 p.m. Between 7 a.m. and 3 p.m. the load never reached 2,500 hp. The minimum was thus about 24 per cent. and the day load under 33 per cent .of the maximum load. Of the day load about 25 per cent. was made up of the 500-volt motor service.

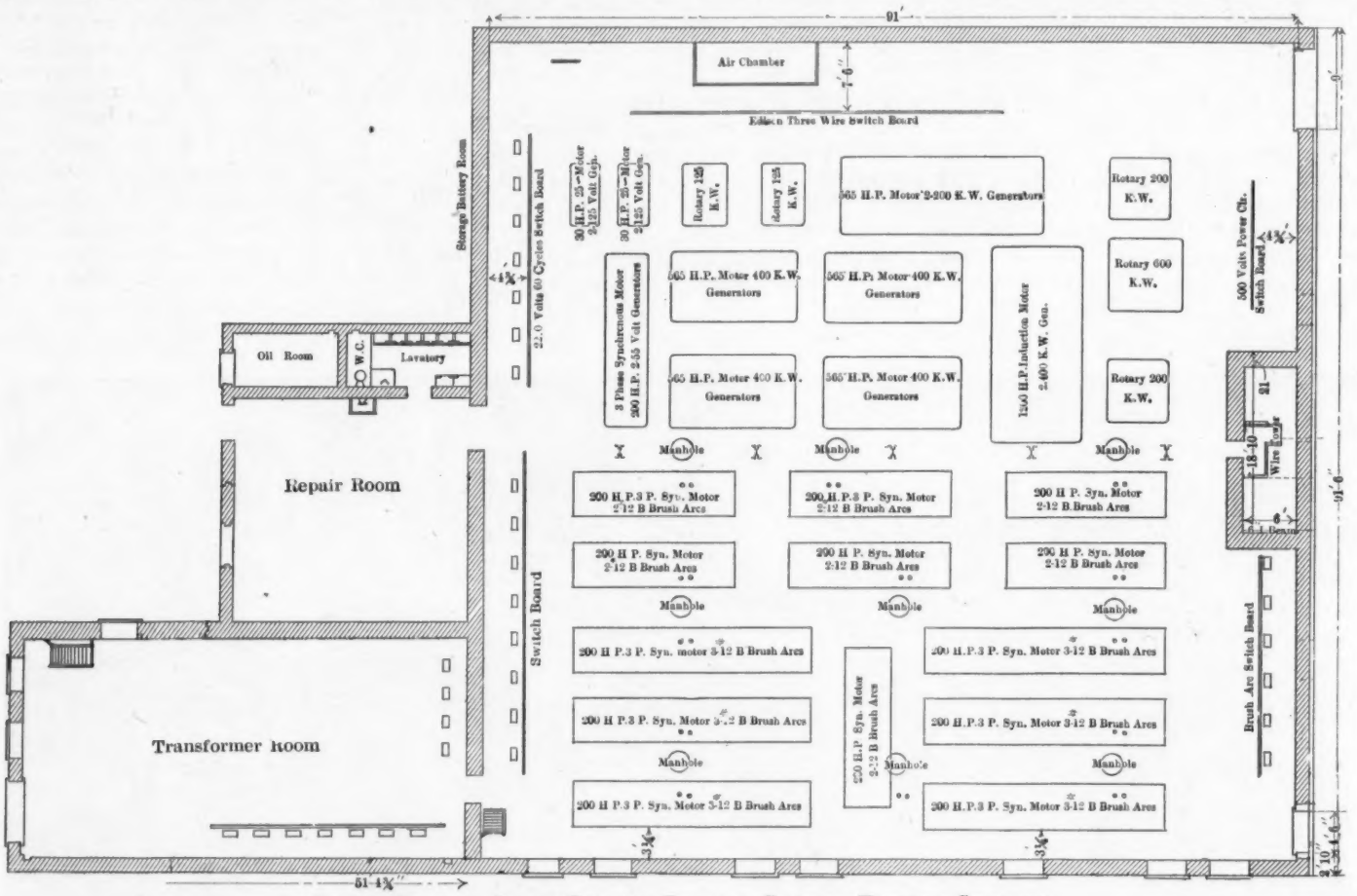

91'
Air Chamber
Edison Three Wire Switch Board
Storage Battery Room
Oil Room
W.C.
Lavatory
22.0 Volts 60 Cycles Switch Board
30 H.P. 25—Motor 2-125 Volt Gen.
30 H.P. 25—Motor 2-125 Volt Gen.
Rotary 125 K.W.
Rotary 125 K.W.
565 H.P. Motor 2-200 K.W. Generators
Rotary 200 K.W.
3 Phase Synchronous Motor 200 H.P. 2-55 Volt Generators
565 H.P. Motor 400 K.W. Generators
565 H.P. Motor 400 K.W. Generators
1250 H.P. Induction Motor 2-400 K.W. Gen.
Rotary 600 K.W.
565 H.P. Motor 400 K.W. Generators
565 H.P. Motor 400 K.W. Generators
Rotary 200 K.W.
500 Volts Power Cir. Switch Board
Manhole
Repair Room
Transformer room
Switch Board
200 H.P.3 P. Syn. Motor 2-12 B Brush Arcs
Wire Basket
I. Beam
Brush Arc Switch Board
250 H.P. Syn. Motor 2-12 B Brush Arcs
61-4¾"

FIG. 2.—PLAN OF POWER STATION, BUFFALO GENERAL ELECTRIC COMPANY.

On December 30, 1903, the minimum load of the International Railway at Buffalo was about 2,300 hp, including the battery charge, at 4.20 a.m. The maximum demand was about 16,400 hp, at 5.50 p.m., and the load on the Niagara transmission from 6 a.m. until midnight ranged about 700 hp. At the time of greatest load on the railway system it drew 7,200 hp from the Cataract Company, and about 9,200 hp from its steam power plant and storage batteries. For the morning peak load of nearly 12,200 hp at 8 a.m. the Niagara transmission furnished 7,300 hp, and during the middle of the day when about 7,000 hp from the falls was still in use the railway load was about 9,000 hp.

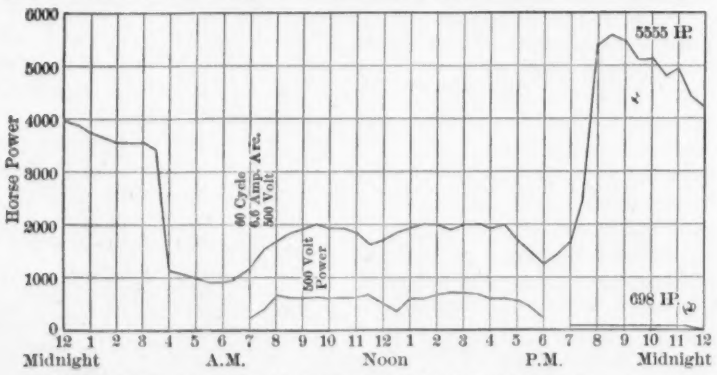


FIG. 3.—BUFFALO GENERAL ELECTRIC COMPANY LOAD CURVE, JULY 20, 1904.

Comparing the December curves of the three systems in Buffalo, it seems that the minimum load of the Cataract Company, at 3.30 a.m., was made up of about 2,700 hp of railway load, a little under 3,500 hp on the lighting system of the Buffalo General Electric Company, and about 1,100 hp on its own 2,200-volt distribution lines. The maximum load of the Cataract Company, at 5.15 p.m., included some 7,500 hp on the system of the Buffalo General Electric Company, 6,800 hp delivered to the railway system, and 9,000 hp absorbed by its private consumers. During the working hours of the December days, from 7 a.m. to 5 p.m., while the railway system was absorbing about 7,000 hp, and about 2,500 hp was going to customers on the lines of the Buffalo General Electric Company, the Cataract Company was distributing some 8,500 hp to its load of large industrial and factory plants. From all this it seems that in winter, as in summer, the greater part of the energy transmitted to Buffalo from

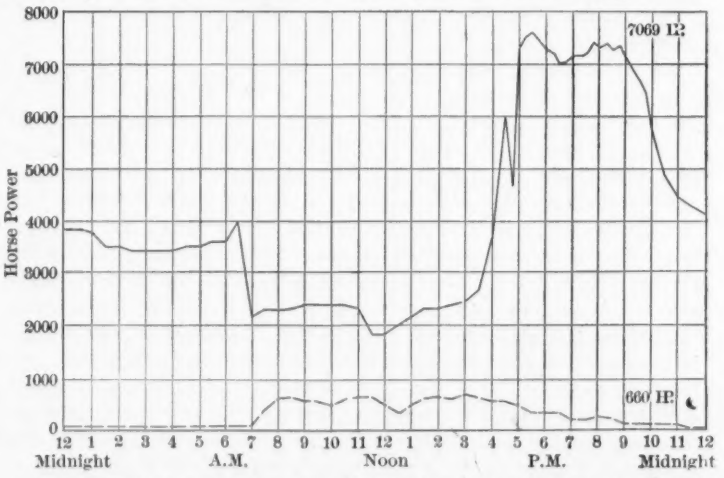


FIG. 4.—BUFFALO GENERAL ELECTRIC COMPANY, LOAD CURVE DEC. 18, 1903.

Niagara Falls is absorbed by the industrial and factory interest at the former city rather than by the commercial lighting and railway loads.

In winter as in summer the curve of power delivered to the railway at Buffalo by the transmission system is approximately a straight line from 6 a.m. to midnight, ranging between 6,000 and 7,000 hp during the former and 5,000 to 6,000 hp during the latter season, for these hours of the day. Between midnight and 6 a.m. the water power curve of the railway drops to about one-third of its reading for the other parts of the day, at all times of year. Storage batteries enable the transmission from Niagara Falls to carry the entire railway load during one-half of each year, and it seems that a larger battery equipment would make it possible for the railway system at Buffalo to operate with energy from the falls during the entire year, with a continuous load of not more than 8,000 hp on the transmission line. Already the Niagara power is used exclusively on all sections of the International Railway system outside of Buffalo; that is, about Niagara Falls, Tonawanda, Lockport and Olcott. In view of the great increase of generating capacity now under construction at Niagara Falls, it is a fair guess that the auxiliary steam plant of the railway system at Buffalo will ultimately be abandoned even for winter use.

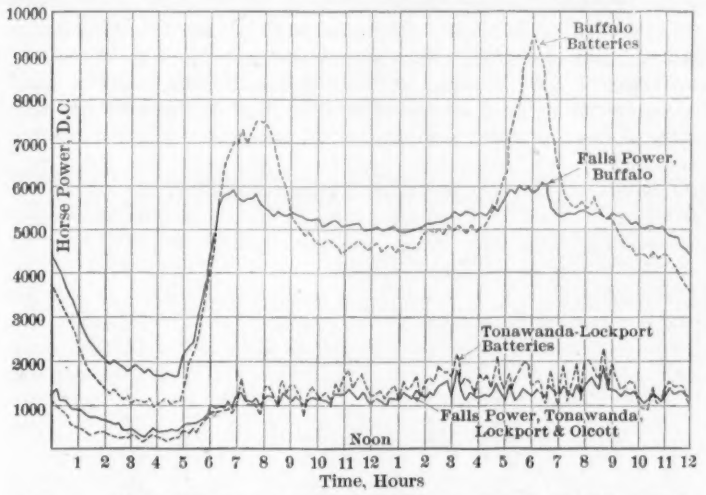


FIG. 5.—INTERNATIONAL RAILWAY COMPANY POWER CHART, JUNE 29, 1904.

DATA FROM CURVES, JUNE 29, 1904.

	Purchased Power.			Storage Batteries.			
	Buffalo.	Tonawanda, Lockport, Olcott.	Total.	Buffalo.	Tonawanda, Lockport.	Total.	Grand total.
Maximum H.P.	6,114	1,985	8,099	3,752	635	4,387	12,486
Minimum H.P.	1,667	319	1,985	79	40	119	2,104
Average H.P.	4,636	1,221	5,857	1,262	274	1,536	7,393
H.P.-hours	111,272	29,302	140,574	8,406	3,480	11,886	152,460
K.W.-hours	83,009	21,859	104,868	6,271	2,596	8,867	113,735

Maximum number of cars in service in Buffalo, 408. Average volts at D. C. busbars, 592.

State of weather: 8 a. m., cloudy; 6 p. m., fair. Temperature: 8 a. m., 66° F.; 6 p. m., 74° F.

THE SUB-STATIONS.

Energy is distributed by the Cataract Company in Buffalo from the terminal house, where the 22,000-volt lines from Niagara Falls enter, and from three other sub-stations. Between the terminal house and the three other sub-stations of the Cataract Company, and also between the terminal house and the four sub-stations of the International Railway in Buffalo, the Niagara current is distributed at 11,000 volts. From the terminal house and the three other sub-stations of the Cataract Company the distribution to private consumers takes place at 2,200 volts with 25-cycle, three-phase current exclusively. At the Wilkeson Street sub-station of the Cataract Company, which adjoins the sub-station of the Buffalo General Electric Company, the 11,000-volt current is transformed to 352 volts and delivered to the company last named, besides being reduced to 2,200 volts and then distributed to consumers. The terminal house contains nine air-blast transformers that operate with 11,000 volts primary and 2,200 volts secondary, three-phase and 25-cycle, besides those that step the transmitted current down from 22,000 to 11,000 volts. Each of these nine transformers of 2,200 volts secondary is rated at 250 kw, so that their combined capacity is 2,250 kw, and they carry a part of the industrial and factory load of the Cataract Company, as already described.

The sub-station of the Cataract Company, on Ohio Street and

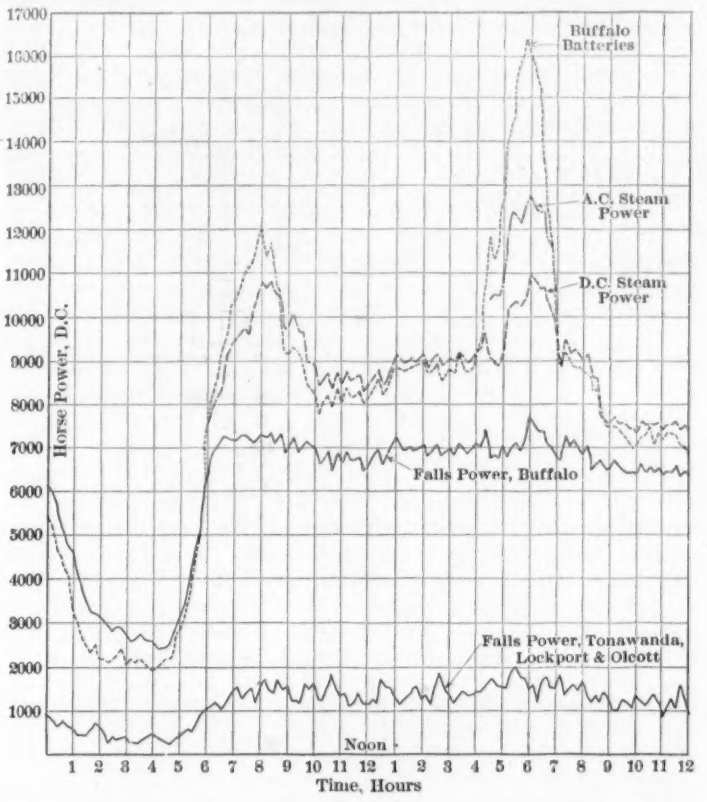


FIG. 6.—INTERNATIONAL RAILWAY COMPANY POWER CHART, DEC. 30, 1903.

DATA FROM CURVES, DEC. 30, 1903.

	Purchased Power.					Steam Power.		
	Buffalo.	Tonawanda, Lockport, Olcott.	Total.	Niagara St.	Virginia St.	Total.	Buffalo.	Grand Total.
Max. H.P. ..	7,622	2,025	9,647	3,414	2,064	5,478	3,970	19,095
Min. H.P. ..	2,303	199	2,502	953	715	1,668	79	4,249
Aver. H.P. .	6,002	1,149	7,151	2,115	1,641	3,756	1,224	12,131
H.P.-hrs.	144,046	27,584	171,630	38,442	4,367	42,809	7,344	221,783
K.W.-hrs. ...	107,458	20,578	128,036	28,678	3,258	31,936	5,479	165,451

Average volts at D. C. busbars, 592.
State of weather: 8 a. m., cloudy; 6 p. m., cloudy.
Temperature: 8 a. m., 20° F.; 6 p. m., 26° F.

Lone Alley, contains six transformers operating between 11,000 and 2,200 volts, and each rated at 850 kw, giving a total capacity there of 5,100 kw. These transformers are oil-insulated and water-cooled. At the sub-station of this same company on Babcock and Hanna Streets the equipment includes nine air-blast transformers of 250 kw

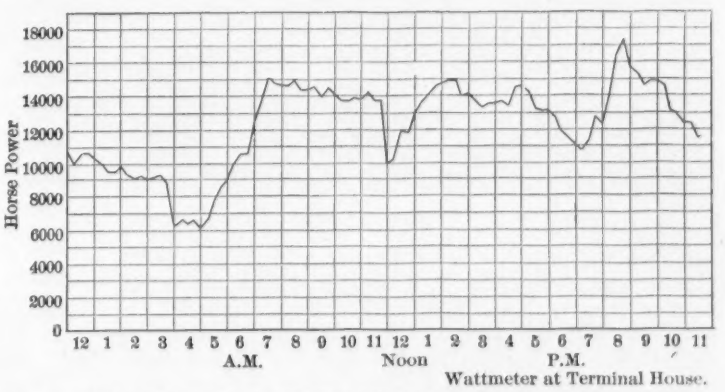


FIG. 7.—CATARACT POWER & CONDUIT COMPANY TERMINAL HOUSE LOAD SHEET, JUNE 18, 1904.

each, a total of 2,250 kw capacity, and these transformers also reduce the voltage from 11,000 to 2,200. In the sub-station on Wilkeson Street the transformers that give 2,200 volts secondary are of the

air-blast type, twelve in number, and each is rated at 250 kw, giving a total of 3,000 kw.

Summing up the capacities of transformers that deliver 2,200-volt current at the terminal station and the three other sub-stations of the Cataract Company their combined rating is 12,600 kw. This

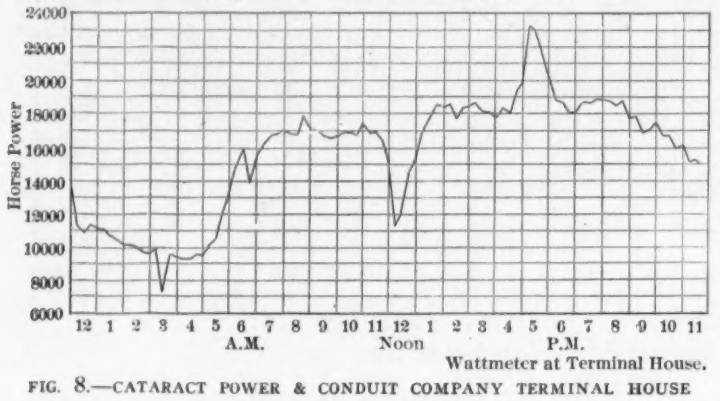


FIG. 8.—CATARACT POWER & CONDUIT COMPANY TERMINAL HOUSE LOAD SHEET, DEC. 18, 1903.

figure is interesting to compare with the 18,124 hp of motor capacity and the 18,642 incandescent lamps that are connected to the 2,200-volt lines of the Cataract Company.

Besides the transformers already mentioned in the Wilkeson Street sub-station of the Cataract Company, there are also 21 air-blast transformers rated at 250 kw each that operate between about 11,000 and 352 volts, for the supply of current at the latter pressure to the equipment of the Buffalo General Electric Company in an adjoining sub-station. The combined rating of these 21 transformers is 5,250 kw, or 7,000 hp, and they are connected to motors of 6,885 hp, and to rotary converters of 1,200 kw capacity, a total equivalent of 8,485 hp. All of these motors and rotary converters receive the alternating current at about 252 volts, 25 cycles, three-phase. Motors to the number of 19 and aggregating 5,625 hp capacity are of the synchronous type, and three motors of the induction type have a total capacity of 1,260 hp. Of the synchronous motors 13, rated at 200 hp each, drive 32 direct-connected arc light dynamos of 8,000 volts and 6.6 amp. each. Six of these motors each drive three of the arc dynamos, and seven motors drive two arc dynamos each. One synchronous motor of 200 hp rating is direct-connected to a pair of 55-volt, 1,091-amp. booster dynamos, used on the 250-volt, three-wire system. Two direct-current generators of 200 kw and 150 volts each are driven by a 565-hp synchronous motor and supply current to this three-wire system, as do also two generators of 400 kw and 150 volts each that are direct-connected to the 1,200-hp induction motor. Exclusive of the booster dynamo the capacity of all generators devoted to the three-wire system is thus 1,200 kw. The 32 arc dynamos above mentioned have a combined capacity of 3,200 enclosed arc lamps, or 1,689 kw.

Commercial lighting service is also supplied in the form of alternating current at 2,200 volts, 62 cycles, two-phase. This current is developed by four generators each rated at 400 kw and direct-connected to one of the 565-hp synchronous motors, giving a total capacity of 1,600 kw for this work. One rating converter of 600 kw and two of 200 kw capacity each receive the 352-volt, 25-cycle, three-phase current from the transformers and deliver current at about 550 volts for the load of direct-current motors, so that the station capacity for this motor load is 1,000 kw. There are also two rotary converters of 100 kw capacity each and a voltage of 125 on the direct-current side, and these may be used on the three-wire system. Two 20-kw, 125-volt exciter dynamos are directly driven by the two 30-hp induction motors, and supply current for the magnet windings of the 2,200-volt, two-phase generators, and for all the rotary converters. In this Wilkeson Street sub-station of the Buffalo General Electric Company the combined capacities of the generators and rotary converters just named amount to 7,716 hp, and the 6,885 hp in capacity of motors used to drive the generators brings the rating of all equipment in the sub-station up to 14,601 hp. This sub-

FIG. 9.—10,000-VOLT DISTRIBUTION SYSTEM CATARACT POWER & CONDUIT COMPANY.

station is a one-story building of brick, steel and concrete, is lighted in part by skylights and contains all of the switching and regulating apparatus necessary for the distribution systems, besides the motors, generators and converters. In floor area the sub-station is 91 by 91 ft., or 8,281 sq. ft., so that the combined capacities of the motors, generators and converters amount to 1.76 hp per sq. ft. It would probably be hard to find another station with as great number and capacity of rotating electrical machines per unit of floor area.

From this sub-station of small size, but large capacity, the great bulk of electric lighting in Buffalo is done. As may be noted from the above, the service includes series arc lighting, 2,200-volt, 60-cycle, three-phase current for distribution to arc and incandescent lamps

through transformers, direct current at about 500 volts for electric motors, and a 250-volt, direct-current, three-wire system for commercial lighting. The series arc lamps are devoted mostly to street lighting, and before 1903 open arcs taking a current of 9.6 amp. were used for the purpose. In that year the system was changed to enclosed arcs that operate with 76 volts and 6.6 amp. each. These lamps are arranged in pairs on iron poles along the long, straight Main Street of Buffalo, and it would be hard to find a better lighted thoroughfare anywhere in the country. A load of comparatively small direct-current motors that reaches as much as 700 hp during

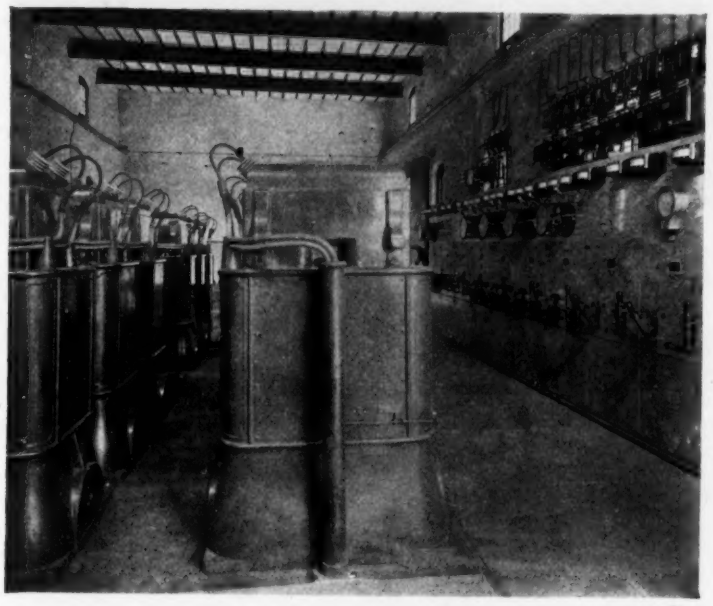


FIG. 10.—STATION NO. 4, 11,000/2200-VOLT SWITCHBOARD.

the day is carried by the 500-volt lines in the main business part of the city.

Service on this motor line is kept up during the entire 24 hours. The three-wire, 250-volt, direct-current system is confined mainly to the business portion of the city, and is devoted to commercial arc and incandescent lighting. Both the residence and business districts are served by the 2,200-volt, 60-cycle, three-phase lighting circuits. Since 1900 there has been a notable growth along all four of the lines of service, though that of the load of series arc lamps has been the least. This growth is well brought out by the record of supply in each of the four systems during December of each year. For the series arc lamps the increase in number between the last month of 1900 and of 1903 was 21 per cent. On the 500-volt power circuits the December outputs in kilowatt-hours rose 114 per cent. between these same years. Energy distributed by the three-wire system during the last month of 1903 exceeded that of the corresponding month of 1900 by 133 per cent. in amount. The 2,200-volt, 60-cycle circuits show the greatest gain with 166 per cent. more energy distributed during the last month of 1903 than in that of 1900. Excluding the series arc system, the other three lines of service of the Buffalo General Electric Company distributed a total of 1,285,000 kw-hours during December, 1903, and of this total output the 500-volt power service represented 10.6, the three-wire, 250-volt service 27.3 and the 2,200-volt, 60-cycle service about 62.4 per cent.

Output of Buffalo General Electric Company during December in each of four years:

Decembef of	Number of series arc lamps operated.	Kw-hours of 500 volt direct current.	Kw-hours of 2,200 volt, 60 cycle, 3 phase current.	Kw-hours of current on 250 volt, 3 wire system.
1900	2,500	63,000	300,000	150,000
1901	2,700	75,000	500,000	250,000
1902	2,900	90,000	650,000	300,000
1903	3,038	135,000	800,000	350,000

In connection with its three-wire, 250-volt system the Buffalo General Electric Company operates a storage battery of 150 cells regularly in series and forty additional end cells. This battery is capable of delivering 3,000 amp. for 1½ hours on both sides of the three-wire system, and is kept constantly in circuit so as to prevent fluctuations of pressure, and to carry a part of the maximum loads. When the Niagara transmission was first connected to the 250-volt, three-wire system at Buffalo, it was thought that good service could be rendered with rotary converters, and this accounts for the two 100-kw, 125-volt rotaries above mentioned. It was found, however, that fluctuations of voltage on the transmission line were communicated to the three-wire system through the rotaries, and they were, therefore, abandoned in favor of motor-generators. One of the motor-generator sets that now supplies the three-wire system is driven by a synchronous and the other by an induction motor, and both are giving good results.

The voltage of approximately 352, at which all of the motors and all of the rotaries save the first two of 100 kw each operate, was selected to conform to the requirements of rotary converters for the 550-volt lines for direct-current motors. This alternating voltage of about 352 is, of course, very easy of insulation and favors economical construction in the motors. Selection of motor-generator sets for the series arc lamps was first dictated in part by a contract for city lighting that called for direct-current lamps, but such excellent service is rendered by the enclosed direct-current arcs that there is no thought of changing to any other equipment. At first only two of the arc lamp dynamos were connected to the shaft of each 200-hp synchronous motor, but later three of the 8,000-volt, 6.6-amp. dynamos were connected to a single motor of this size. All of the synchronous as well as the induction motors in the sub-station of the Buffalo General Electric Company have fixed external armatures and the synchronous motors have internal revolving magnets. The synchronous motors direct-connected to the 62½-cycle, two-phase, 2,200-volt generators each have eight poles and operate at 375 r.p.m. Each of these generators has 20 poles, or 2½ times the

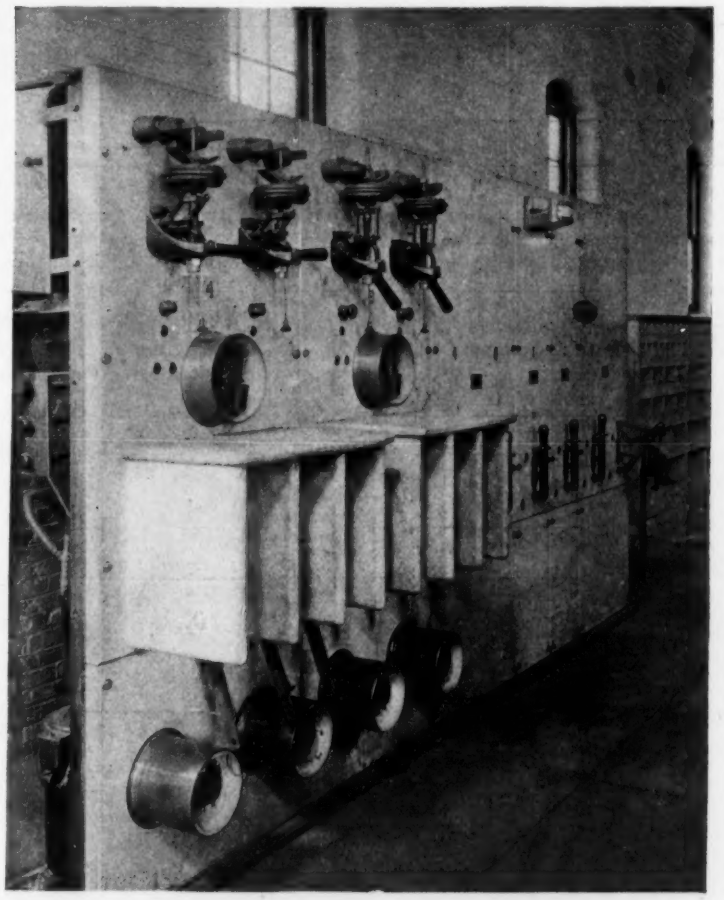


FIG. 11.—PRIMARY SWITCHBOARD, 11,000 VOLTS; STATION NO. 4.

number in its direct-connected motor, and this accounts for the rather odd number of 62½ cycles per second.

Each of the synchronous motors is started by connecting its armature to the 352-volt, three-phase bus-bars through three single-pole, double-throw knife switches and three reactive coils. After these connections are made the motor comes up to synchronous speed in less than a minute, and with about 1½ times its full rated current. As soon as synchronous speed is reached, as indicated by the absence of any sparks when the blades of the double-pole field switch are brought into light contact with and then moved away from the terminals of the non-inductive resistance provided for the field dis-

charge, the field switch is fully closed, and the three single-pole switches are reversed to join the armature directly with the three-phase bus-bars. Rotary converters that supply the 500-volt motor system are started in the same way from the alternating-current bus-

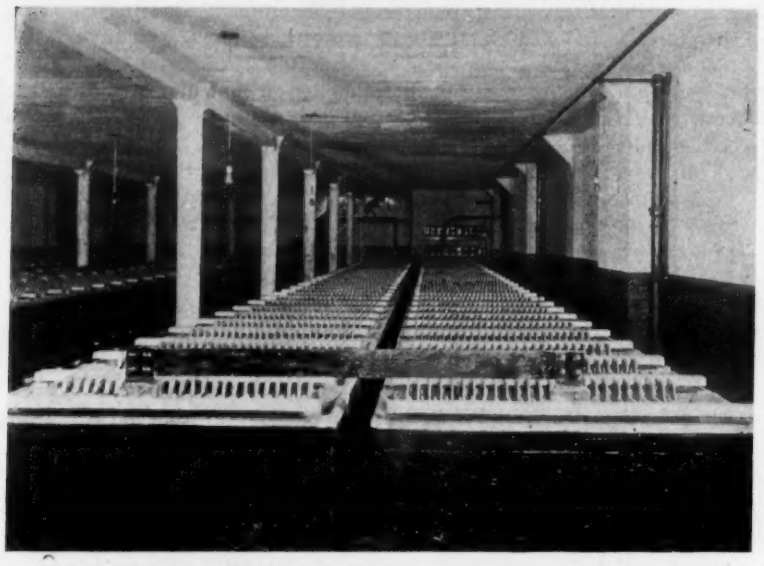


FIG. 12.—VIRGINIA STREET SUB-STATION, INTERNATIONAL RAILWAY COMPANY, BUFFALO.

bars, though in this case the magnets are stationary and the armatures revolve.

On July 1, 1904, the connected load of the Buffalo General Electric Company was as follows:

Series arc lamps for Buffalo	2,759
Series arc lamps for commercial	245
Series arc lamps for West Seneca	104
Direct-current arc lamps in multiple	596
Direct-current 16-cp incandescent lamps	30,008
Alternating current arc lamps in multiple	1,415
Alternating current 16-cp incandescent lamps	88,641
Total horse-power of connected motors	3,085

The summary of these lighting loads is 4,119 arc and 118,649 incandescent lamps. To these figures may be added those for the 18,642 lamps and 18,124 hp of motor capacities connected to the lines of the Cataract Power & Conduit Company, also the 1,500 hp capacity of the motor that is to drive the pumps at the city water works.

located with the steam power plant at Niagara and School Streets, another is at Seneca and Elk Streets, a third at Walden Avenue and Belt Line and the latest and largest at Virginia and Washington Streets. The last-named sub-station is located near the load center of the city lines and contains four three-phase transformers of 1,000 kw each, four six-phase rotary converters of 1,000 kw each and two storage batteries each consisting of 288 cells and rated at 1,300 kw for one hour. Beneath the main floor of this sub-station there is an air pit for the transformers and masonry compartments for the 11,000-volt bus-bars, and at one corner there is a large manhole where the cables going to these bus-bars enter. One of the 1,000-kw, three-phase transformers is connected to each rotary and forms therewith an operating unit. The primary coils of each transformer go to the 11,000-volt bus-bars through both oil and knife switches, and these latter serve to separate the oil switches entirely from the 11,000-volt bars. With the storage batteries the Entz system of regulation is used and the fluctuations of station load are said to be thereby reduced below 10 per cent. For starting each of these 1,000-kw rotaries there are switches that connect the armature through reactive coils with transformer taps of one-third, two-thirds and full secondary voltage. In this way the loss of time that would be required for synchronizing is avoided. At this sub-station the capacity of all four rotaries is 4,000 kw, or 5,300 hp, and the combined capacities of the rotaries at the other three sub-stations in Buffalo brings the total up to about 10,000 hp. The Virginia and Washington Street sub-station is constructed of brick, steel and masonry, and has room for three more of the 1,000-kw rotaries, with their transformers, and for one more storage battery of 1,300 kw-hour rating. At the station on Niagara and School Streets, which also serves as a sub-station, as noted above, there are two 1,500-kw, 25-cycle, three-phase alternators, and three 800-kw, 600-volt, direct-current generators, each driven by a direct-connected steam engine. These generators are not operated between May first and October first in each year, when Niagara power carries the entire load of the railway system. At this station there is also a storage battery of 1,800 amp.-hour rating.

Between the terminal house of the Cataract Company, its three other sub-stations and the four sub-stations of the railway system, the 11,000-volt, three-phase, 25-cycle current is distributed by about 48 miles of underground cables. Each cable carries three 3/0 B. & S. gauge copper conductors, separately insulated, and all covered with an outside lead sheath. In about 18 miles of cable the insulation is paper, and in about 30 miles it is rubber. All of the cable is laid in glazed tile conduits. Five separate cables of these types leave the terminal station and at least two of these cables enter each sub-

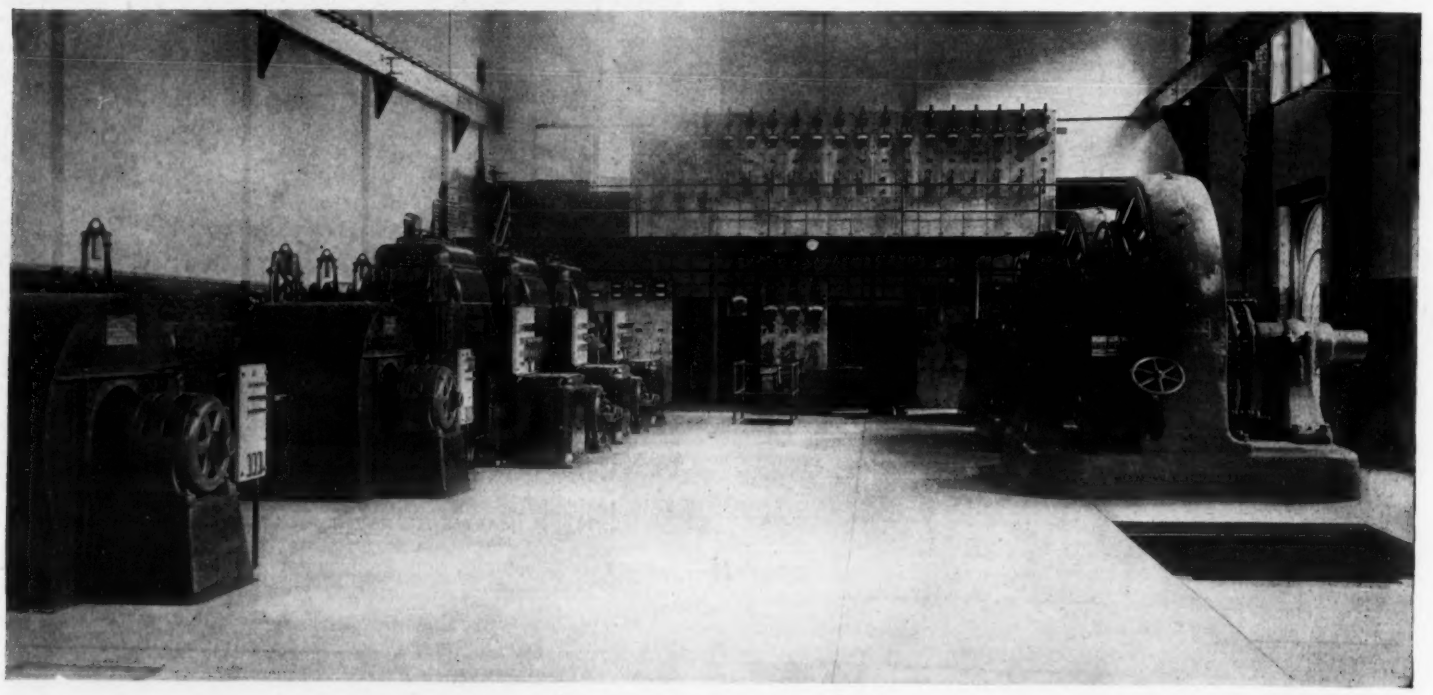


FIG. 13.—INTERIOR OF TRANSFORMER STATION, INTERNATIONAL RAILWAY, NORTH TONAWANDA.

For the International Railway system in Buffalo the 11,000-volt, three-phase, 25-cycle current from the terminal house of the Cataract Company is received, transformed and converted to direct current of about 600 volts at four sub-stations. One of these sub-stations is

station. Where only two cables enter a sub-station the capacity of each is great enough to carry the entire load there, and in sub-stations where more than two cables enter the load can be carried by less than the entire number. Into the two more important sub-

stations of the Cataract Company loops from three or four of the cables are carried instead of taps, by means of which cross connections can be made to cut out a damaged section of cable between them. At intervals of about one mile along the cables oil switches are installed in water-tight iron boxes located in manholes, so that a faulty section in any one cable may be entirely disconnected.

At the sub-stations and at the terminal house each of the underground cables is connected through a time limit oil circuit-breaker,

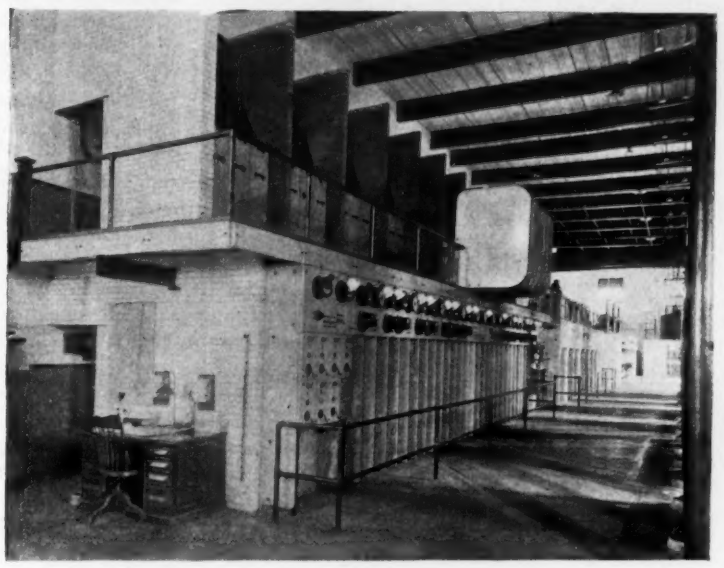


FIG. 14.—TERMINAL HOUSE; 11,000-VOLT DISTRIBUTION BOARD.

so that when loaded above its capacity because of a defect in the cable or from any other cause it is soon cut out. In this way a fault in one of the cables entering a sub-station might draw more than the normal current through one or more other cables entering the same sub-station, and so cause all of them to be automatically disconnected. To prevent this last-named action a reverse-current circuit-breaker is connected in each cable at the sub-stations. This circuit-breaker disconnects its cable from the bus-bars at the sub-station, where it is located whenever there is a flow of energy from these bus-bars into the cable, as there would be if a section of the cable developed a short-circuit.

The terminal house of the Cataract Company on the Erie Canal, at the foot of Ontario Street, is a one-story brick structure with steel truss roof. Into this building come three 22,000-volt, 25-cycle,

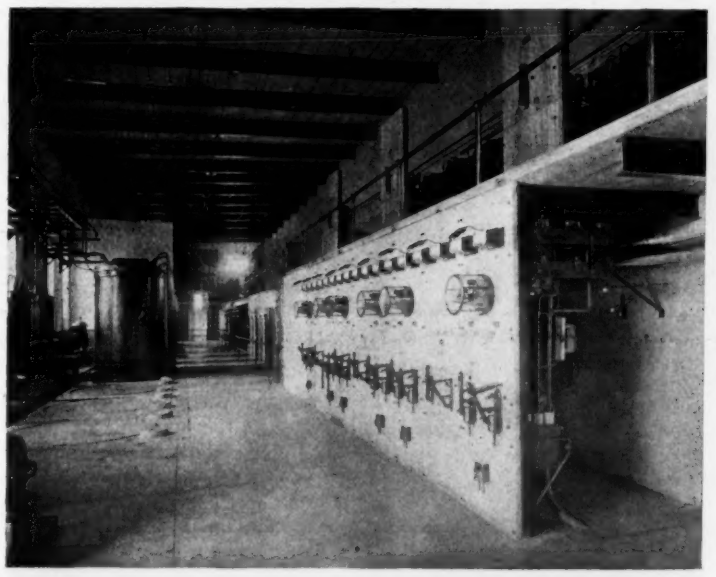


FIG. 15.—TERMINAL HOUSE, LOOKING TOWARD WEST END OF BUILDING.

three-phase circuits from the transformer house of the Niagara Falls Power Company some 23 miles away by the longer and about 20 miles by the shorter line. The two longer transmission circuits are mounted on the same pole line and each is composed of three bare copper cables of 350,000 c.m. area. For each circuit the three copper cables are arranged on one side of the pole in triangular form 36 in. apart, two cables being carried by an upper and the third by the lower cross arm. On the run from Niagara Falls to Buffalo the conductors of each of these two circuits are transposed five times. These circuits are carried on porcelain insulators that have double petticoats, are each 7 in. in diameter, and that hold the cables 7½ in. above the cross arms. Each cross arm is 12 ft. long and has a section of 4 by 6 in. Poles for this line are white cedar, extra heavy,

FIG. 16.—TERMINAL HOUSE, 2250-KW TRANSFORMERS.

have a regular length of 35 ft. and are set 70 ft. apart on tangents, but are closer on curves. Each insulator pin on this line has a top diameter of ⅞ in. and a shank diameter of 2 in.

For the third circuit between the transformer house at Niagara Falls and the terminal house in Buffalo three stranded aluminum conductors with a cross section of 500,000 c.m. each are used. The pole line carrying this circuit diverges at Tonawanda from the one above

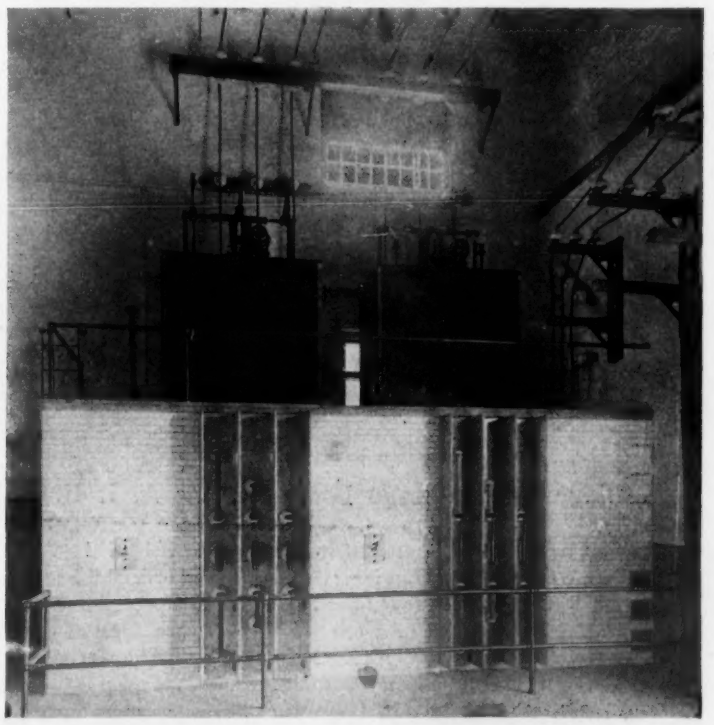


FIG. 17.—EAST END OF TERMINAL HOUSE, SHOWING SELECTOR SWITCHES AND OIL SWITCHES FOR 22,000 VOLTS FOR BANK 3 AND FUTURE BANK 4.

mentioned, and has a length of about twenty miles. Owing to its cross section, length and material this third circuit has very nearly the same resistance as each of the other two. The aluminum circuit has bare conductors save for a short distance in Niagara Falls, where they have braided covers treated with asphaltum, because exposed to fumes of chemical works. Poles for the aluminum line are set 140

ft. apart on tangent sections, and the three conductors are arranged 36 inches apart in triangular form as on the other line. Each insulator for the aluminum conductors has double petticoats of nearly equal size. The larger being 7½ in. in diameter, holds its wire 10 in. above the cross arm, and is of porcelain. Pins for these insulators are 1½ in. in diameter at their tops, 2¼ in. at the shanks and set in cross arms that are 5 by 6 in. in cross section. Nine threads on each pin engage with those in its insulator.

The two copper circuits enter at one end of the terminal house and the aluminum circuit at the other end, and each circuit has its strain taken up on large braced poles with double cross arms before it passes to the end wall. Each conductor enters the building through a porcelain tube 12 in. long that slopes toward the outside and is supported by a board of pine 1 in. thick set in an opening of the brick wall. Over the entry thus formed in the wall there is a metallic awning to protect it from snow and rain. At 7 per cent. loss the capacity of each of the three transmission circuits between Niagara Falls and the terminal house at Buffalo is about 10,000 hp, so that the total line capacity is 30,000 hp with this loss.

Inside of the terminal house the 22,000-volt lines are first connected to lightning arresters of the multi-gap type, and then pass through reactive coils to circuit-breakers that in part of the open air and in part of the oil type are electrically operated. Each circuit then goes to double-throw knife switches that connect with either of two duplicate sets of 22,000-volt bus-bars. With either set of these three-phase bus-bars the step-down transformers connect through other switches in groups of three. The transforming ratio of these groups is two to one, and their secondary coils deliver the 11,000-volt, 25-cycle, three-phase current through other sets of switches to either of two duplicate sets of bus-bars.

These 11,000-volt bus-bars form a part of seven switchboard panels on which are mounted the indicating and recording wattmeters for the transmitted power, besides control switches and other apparatus. For the reduction of pressure from 22,000 to 11,000 volts three groups of transformers, corresponding to the three transmission lines, are provided. Nine transformers are thus used and the rating of each is 2,250 kw, giving a combined capacity of 20,250 kw or 27,000 hp, as previously noted. These nine transformers are all of the oil-insulated, water-cooled type, and the primary and secondary coils in each group of three are respectively connected in delta. From the 11,000-volt bus-bars connected with these transformers all of the sub-station apparatus above noted is supplied.

At the transformer house in Niagara Falls the step-up transformers that supply the three Buffalo transmission lines can be connected to any of eleven 5,000-hp generators in the two power houses on the American side of the falls that are owned by the Niagara Falls Power Company. As soon as completed the plant of the Canadian Niagara Power Company will be electrically connected with the two just named, and thus render even more reliable the supply of Niagara power in Buffalo.

The facts in this paper have been gathered through the kindness of Mr. C. R. Huntley, general manager of the Cataract Power & Conduit Company: Mr. Elwood Grissinger, engineer, and Mr. Alverson, superintendent of this company; Mr. G. F. Sellers, of the Buffalo General Electric Company, and officials of the International Railway Company.

Meeting of the Chicago Branch of the A. I. E. E.

The first meeting of the year of the Chicago branch of the American Institute of Electrical Engineers was called to order by Secretary Junkersfeld at 8.15 p.m., November 29, in the rooms of the Western Society of Engineers. A new executive committee for the coming year was elected as follows: H. M. Brinckerhoff, J. R. Cravath, E. B. Clark, C. E. Freeman, P. Junkersfeld, A. D. Lundy, K. B. Miller, H. H. Wait and P. B. Woodworth.

There being no further business, Mr. James Lyman presented a paper, "Observations of European Lighting and Railway Practice." Mr. Lyman prefaced his paper by a few general remarks, stating that his trip abroad was simply one with his family for pleasure and that no notes were taken on the electrical features. The European street railway systems, he said, were in general not up to American practice. The cars were small, with double deck and single truck, and were usually driven by two 15-hp motors. The street railway system of Liverpool, however, was a notable exception to the usual type of European road. The 500 cars of the system are driven by two 25-hp motors of the American Walker type. Power is supplied by two stations about three miles apart, equipped with 800-kw units.

Fares are charged according to the distance. For distances under two miles 1 penny or 2 cents is collected, and the same rate is charged for greater distances up to 10 miles. Of the fares 90 per cent. are of the one-penny class. The wages of the motormen are from 12 cents to 13 cents per hour, while the conductors receive about two cents less per hour. The cost of living in England, which Mr. Lyman stated is about half that in America, offset the seeming low wages.

The railway system of Glasgow is also operated by the city. This was not, however, as successful financially as the Liverpool system. The system at New Castle was just paying expenses.

Mr. Lyman then made a few remarks concerning the London railway systems. The Central London Underground Railway extends a distance of 6 miles, from Shepherds Bush to the Bank of England. The motor cars are equipped with two General Electric 66 motors. The trains, which consist of four motor cars and three trail cars, are run under three-minute headways. The movement of the air by the trains is largely depended on for ventilation, but a 200-hp exhaust fan is also installed. A fare of 4 cents is charged. Mr. Lyman also spoke of the main features of the Metropolitan District and the Metropolitan underground railroads.

The North Eastern Railway, which operates through a thickly populated manufacturing district, and which was recently changed from steam to electric traction, operates 6-car trains at 5-minute headway. The cars are equipped with two 150-hp General Electric motors. The capacity of the terminal station has been increased 50 per cent. over that when steam locomotives were used, because of the fact that the trains may be operated from either end. This road uses electric locomotives in hauling freight cars, which consist largely of fish cars from Tynemouth.

In general the English installing engineer is much more hampered by specifications than is the engineer of America. These specifications often require apparatus not of standard design and thereby increase the cost of the installation. The units of the power plants are, as a rule, not as large as those in America. Their overload capacity, too, is much less, being only about 10 per cent. Another instance in which practice differs from the American custom is in the use of storage batteries. These are floated on the line through boosters, while Americans prefer to use end cells for regulating the voltage on central station lighting batteries.

Before proceeding with the discussion of Mr. Lyman's paper, which dealt also with France, Switzerland and Germany, Mr. George A. Damon gave an abstract of a paper by O. S. Lyford, Jr., and W. N. Smith, on "Problems of Heavy Electric Traction," which was presented to the Institute at New York. Mr. Damon remarked that the general subject of electric traction was quite different from what it was a year ago. Then there was an enthusiastic wave in favor of the single-phase motor. This wave has subsided and it was now generally regarded that the traction problem coincided with that of lighting in that direct current was best suited where traffic was dense, while alternating current would probably be adopted for scattered work. At the conclusion of his abstract Mr. Damon remarked that one of the points to be got from the paper was that it appeared to be a waste of time to employ calculus in the deductions of the probable duty of railway motors, and afterward select a motor 50 per cent. larger than the computed capacity in order to accommodate future demands.

Secretary Junkerfeld then announced the subjects of the evening open for general discussion. In response to the question as to what he thought of the bow trolley, Mr. Lyman stated that these were in use largely on small single-truck cars having two 15 or 25-hp motors. The bows were made of aluminum and lasted indefinitely. He doubted if they would be a success on the larger equipments.

Concerning the reserve capacity of lighting plants, it was stated that 40 of the largest foreign plants carried 80 per cent. reserve power, while 40 American plants carried but 40 per cent. and the greater number carried but 10 or 20 per cent. In reply to the question as to how the foreign companies managed to pay dividends on the large investments, Mr. Lyman stated that the companies were satisfied with small returns, and that there was no watered stock. If the plants were worked as hard as those in this country they would pay excellent returns.

An Electrolytic Wireless Telegraph Detector.

BY DR. JAMES E. IVES.

IN a paper read before the recent International Electrical Congress at St. Louis, Dr. Lee de Forest described a form of electrolytic oscillation detector used by the De Forest Wireless Telegraph Company.

This detector is an electrolytic cell, in which the anode is a very fine platinum wire dipping to a slight distance beneath the surface of the electrolyte, and the cathode is a heavier platinum wire immersed to a considerable distance.

A simple form of such a cell is shown in Fig. 1, where *s* is an adjustable screw, *e*, the electrolyte, p_1, the very fine platinum wire, p_2, the heavier platinum wire.

Any aqueous solution may be used as the electrolyte, but solutions of the alkaline salts give the best results.

The distance to which the very fine platinum wire should be immersed depends upon its diameter. For a wire about 40 millionths of an inch in diameter, a depth of immersion of about 3 thousandths of an inch gives the best results. The greater the diameter of the wire, the smaller must be the depth of immersion. The fine platinum wire may have a diameter anywhere from a few millionths to a thousandth of an inch.

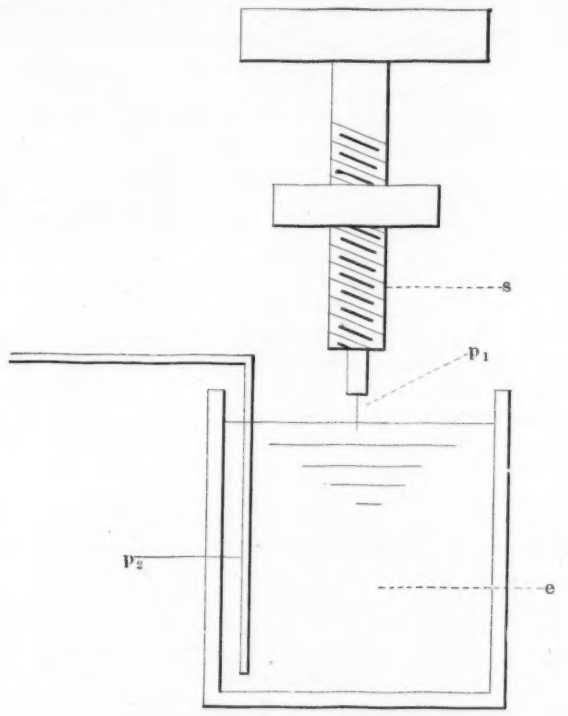


FIG. 1.—SIMPLE FORM OF CELL.

A diagram of the local circuit containing the detector, *D*, a telephone, *T*, potentiometer, *P*, and battery, *B*, is shown in Fig. 2. When receiving wireless telegraph signals one side of the detector may be connected to the aerial wire, *a*, and the other side to the earth wire, *e*. When a signal is received a musical sound is heard in the telephone, its pitch being that of the sending spark.

Dr. Lee de Forest, as already stated, holds that this device is electrolytic in its nature, and operates in virtue of the electrolytic action within it. Prof. Fessenden holds that it operates in virtue of heat generated in the electrolyte surrounding the immersed portion of the fine wire when a Hertzian oscillation passes through the detector. W. Schloemilch (*Elektrotechnische Zeitschrift*, November 19, 1903) is uncertain whether it operates in virtue of its polarization capacity or its ohmic resistance. M. Reich (*Physikalische Zeitschrift*, June 15, 1904) believes, as a result of his experiments, that it acts by the polarization of the small surface of the immersed portion of the fine platinum wire. This opinion is shared, both on experimental and theoretical grounds, by M. Dieckmann (*Physikalische Zeitschrift*, August 15, 1904). F. K. Vreeland ("The Principles of Wireless Telegraphy," McGraw Co., 1904, pp. 188-191) believes that it is an electrolytic device depending for its action upon polarization.

To determine the precise nature of the action, experiments were carried out by the author in the Research Laboratory of the American De Forest Wireless Telegraph Company. While conducting these experiments the writer was indebted for valuable suggestions to Dr. Lee de Forest, and to Mr. Greenleaf Whittier Pickard. Mr. Pickard has also made a series of experiments, the results of which are in complete accordance with those here described. These experiments show beyond a doubt that the detector is electrolytic in its action, and not a heat-operated device. Its operation apparently depends upon the polarization by electrolysis of that portion of the surface of the fine platinum wire which is in contact with the electrolyte. The ability of the device to detect wireless telegraph signals is explained if we assume that the e.m.f. generated in the aerial wire by the received Hertzian waves causes a partial breaking down of the polarization layer enveloping the immersed part of the fine platinum wire, and thus reduces the apparent resistance of the local circuit. The electrolytic polarization theory of action is supported by the following facts, which I have ascertained in the course of my experiments:

1. It is found that the device is *not reversible;* that is, if the fine wire is made the cathode of the cell and the stouter platinum wire the anode, the device responds only very faintly to Hertzian wave signals. This fact shows that it cannot be simply a heat-operated device, for if it were the heat generated would depend only upon the rapidly oscillating current flowing through it, and this would be independent of the polarity of the cell.

2. I find that the fine wire forming the anode of the cell must be made of a metal which is chemically inert in the electrolyte. Since the fine wire is the anode of the cell, oxygen is liberated at its surface. It is found that if the metal of the wire is of such a nature that the oxygen liberated at its surface combines with it, the device will not respond, even although the wire be fine enough to respond if it were of platinum. For instance, I found that, using fine wires or filaments of the same diameter, platinum, carbon and aluminum will respond, whereas iron will not. Aluminum probably responds in virtue of the existence of the well-known film of oxide which is formed upon it. These facts seem to show that a film of gas or its equivalent is necessary at the surface of the fine wire to produce the result. If it were a heat effect a slight chemical reaction at the surface would not have any appreciable effect upon the heat produced by the rapidly oscillating current passing between the surface of the fine wire and the surrounding electrolyte.

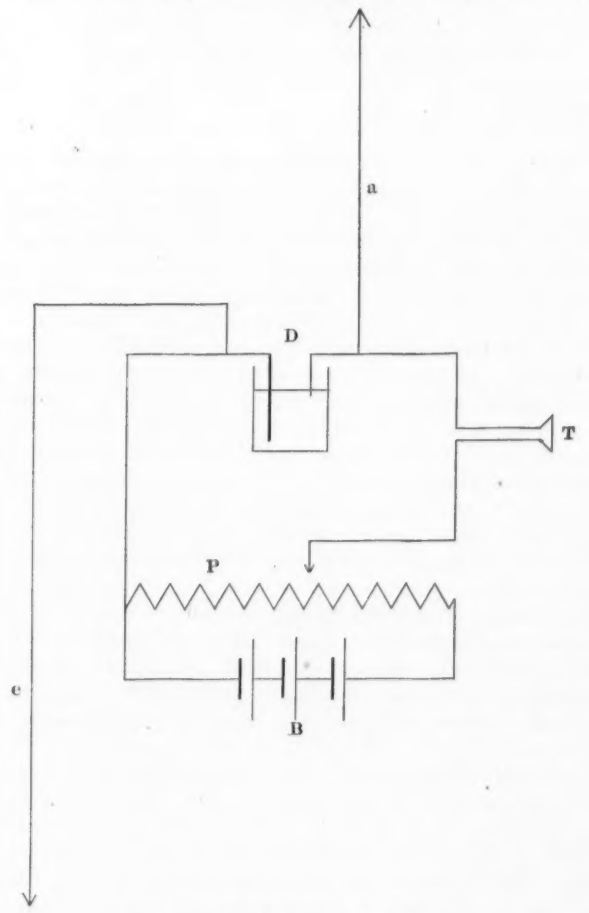


FIG. 2.—DIAGRAM OF LOCAL CIRCUIT.

3. The device, when used in the usual manner with a local battery, has a very high *apparent* resistance, very much greater than that which could be due to its true ohmic resistance. The value of this apparent resistance also depends upon the method of measuring it, having its smallest value when the cell does not have an opportunity to become polarized. It is also found that this apparent resistance depends upon the amount of the e.m.f. in the local circuit, apparently *increasing* very rapidly as the local e.m.f. is *decreased*. It may increase from a few thousand ohms for a local e.m.f. of four volts to several million ohms for a fraction of a volt.

4. I find, after most careful and elaborate experiments, that the sensitiveness of the device to Hertzian waves depends only upon the *area* of the minute platinum surface forming the anode and not upon its *shape*. For instance, it is found that if a one-mil platinum wire is sealed into a capillary glass tube, and the end of the capillary tube is filed off squarely, the cross-section of the one-mil wire which is exposed will form an anode which is quite as sensitive as an anode formed by a fine platinum wire 3/1000 of an inch long and only 38/1,000,000 of an inch in diameter. Although the shape of these two surfaces is entirely different, the area is of the same order, namely, about one millionth of a square inch.

5. From the behavior of the detector in the field, it appears to be a potential-operated device, and not a current-operated device, as it should be, if its action were due to a heat effect. It is found that this detector will respond very well without any ground connection, which it would not be likely to do if it were a current-operated device.

6. It is found that the detector will respond when the electrolyte in which the fine wire is immersed is actually boiling. This could not happen if its action were due to heat, as is believed by Prof. Fessenden, since the electrolyte being at or near the boiling point, the heat alleged by him to be developed at the anode by the Hertzian currents would cause a boiling of the liquid at the minute surface of the anode and thus interrupt the action. The apparent increase of resistance of the device when receiving is actually very great, and can be approximately estimated by observing the *change* in the current in the local circuit when the instrument is responding. The apparent change in resistance, of course, depends upon the intensity of the incoming Hertzian waves, and therefore upon the intensity and distance away of the source. Under ordinary circumstances the resistance often drops to one-half or to one-third of its original value. If the device were heat-operated, such a change as this in the resistance would represent a considerable amount of heat developed at the anode, and if the electrolyte were already at, or in the neighborhood of its boiling point, it would certainly cause an evolution of vapor at the anode and a consequent interruption of the action. This, as I have stated, does not occur, even when the electrolyte is boiling violently, if proper precautions are taken in making the experiment. If a fine platinum wire is used, dipping just beneath the surface of the electrolyte, trouble may be experienced owing to the fact that when the liquid is boiling violently, its surface is disturbed, and the point may fail to make contact with the liquid. This difficulty may be overcome by using an anode of a form already described, namely, a one-mil platinum wire sealed into a capillary glass tube, and filed off squarely at the end. It is found that when this is immersed to a slight depth beneath the surface it will respond with perfect regularity, no matter how violently the electrolyte may be boiling.

7. A beautiful proof that it is not a heat device is an experiment that I have performed showing that it will work perfectly even when the electrolyte has a zero temperature coefficient of resistance. For this purpose I used a 2½ per cent. solution of hypophosphorous acid. This electrolyte has a zero temperature coefficient of resistance at about 60° C. Below this temperature its resistance coefficient is negative, and above it positive. I observed the response of the device when using this electrolyte, and found that there was a slight ature rose from the temperature of the room (about 30° C.) to its boiling point, in the neighborhood of 100° C. There was no trace of a minimum of response, much less was there a zero point of response, anywhere between these temperatures. I determined the temperature of minimum resistance for this electrolyte by a separate experiment.

8. I will now describe what I regard as the most beautiful and conclusive of all the experiments. It is well known that when two bright platinum surfaces are immersed in an electrolyte and an e.m.f. is applied to them, they become polarized. It is also well known that this polarization can be destroyed by coating the bright surfaces with platinum black, platinum black being a powder-like form of platinum. When the ohmic resistance of an electrolyte is measured between two platinum electrodes, these electrodes always have to be coated with platinum black to get rid of apparent resistance introduced by polarization. Since coating by platinum black is a well-known cure for polarization it occurred to me that if the action of the detector depended upon the polarization of the fine platinum wire forming the anode, coating this fine wire with platinum black should render it inoperative. At the same time, the thin coat of platinum black could not interfere with the heat action, if such existed, if it were made so thin as not to appreciably increase the diameter of the fine wire. I accordingly platinized the fine wire by the usual method, making it one of the electrodes of an electrolytic cell containing a solution of platinum chloride. Examination under the microscope showed that a smooth coat of platinum black had been deposited upon the wire, the thickness of which was not greater than one-tenth of the diameter of the fine wire itself. Since the fine wire, in this case, had a diameter of 38/1,000,000 of an inch, the thickness of the coating of platinum black was not more than 4/1,000,000 of an inch. Such a thin coating as this could not sensibly change the heating effect in the electrolyte if such heating actually occurred. The diameter of the fine wire when platinized could not have been more than 56/1,000,000 of an inch, and I have found that a wire 90/1,000,000 of an inch in diameter is practically as sensitive as the 38/1,000,000 wire. Even a one-mil wire will respond if only the end of it is immersed in the electrolyte. It was found that the coat of platinum black entirely destroyed the sensitiveness of the detector. In fact, when the fine wire was completely coated it would not respond at all. The experiment was performed by noting the response before platinizing and after platinizing, under exactly the same conditions with respect to the electrolyte and depth of immersion in the electrolyte. In order to do this the electrolytic cell was placed under a microscope, so that the fine platinum wire could be carefully observed in every stage of the experiment. In this experiment the fine wire was usually immersed to a depth of about 4/1000 of an inch or to about 100 times its diameter. When carefully platinized, no response could be obtained even if the amount of immersion was made the very smallest possible.

From the preceding experiments I think it is evident that this detector of Hertzian waves is electrolytic in its action, depending upon the polarization of the fine platinum wire forming the anode of the cell.

Although its use as a Hertzian wave detector does not apparently depend upon the rectification of the Hertzian currents in the aerial wire, it is capable of being used as a rectifier. Mr. Pickard has actually observed these rectified Hertzian currents. As a rectifier it is essentially similar in structure to Pupin's electrolytic rectifier (see *Bulletin* American Physical Society, Vol. I, p. 21, 1900; U. S. Patent Specification No. 713,045). In this device the anode consists of a one-mil platinum wire sealed into a capillary glass tube, ground off squarely at the end, and the cathode consists of a small platinum plate. The use of this device as a rectifier and also as a Hertzian wave detector depends upon the existence of a polarization layer upon the small surface of the anode.

I find that to get good results with this detector the surface of the cathode should be much greater than that of the anode. If the surface of the cathode is made very small the sensitiveness of the device is very much decreased, and the response in the telephone is very faint. This is probably due to the fact that the effective electric valve action takes place only at the anode, and consequently the only result of reducing the surface of the cathode is to decrease the local current through the detector, and consequently to decrease its sensitiveness. It is interesting to note that the effective valve action is at that electrode at which oxygen is liberated. It is well known that oxygen is *adsorbed* by platinum; that is, is condensed upon its surface. Such an action would undoubtedly give rise to a polarization film. It is a question as to whether such a layer of oxygen is in a gaseous or in a liquid state, or is perhaps in a condition of unstable chemical union with the platinum.

Most of the experiments described were carried out in such a manner that the fine wire could be seen under a microscope. In this way its depth of immersion and its behavior in the electrolyte could be accurately observed. It was noticed that when a signal was received by the aerial wire one or more bubbles of gas were usually formed at, and set free from, the fine wire. The stronger the signal,

the more bubbles were formed. For a weak signal only one bubble might be formed. This bubble was usually formed at the same place on the wire each time, but not necessarily at its end. Weak signals could be received and heard in the telephone without the apparent formation of any bubbles.

There is an interesting resemblance between this detector and the Wehnelt interrupter, the two devices differing principally in the magnitude of the quantities involved. In both the anode is very small compared with the cathode, and the action is due to the formation of gas at the surface of the anode.

I would suggest that this electrolytic detector might be called a *polariter,* since its action depends upon the polarization and consequent polarity of an electrolytic cell. The *coherer* depends upon the tendency of two clean and dry metallic surfaces to cohere under the influence of Hertzian impulses; the *barretter,* upon the heat generated by Hertzian currents in a conductor of small cross-section; and the *polariter* upon the breaking down of a polarization film in an electrolytic cell.

The Predetermination of Plunger Electromagnets.*

BY PROF. SILVANUS P. THOMPSON, F.R.S.

AN impression seems to be abroad that the known laws of electromagnetism do not suffice to enable the pull of the solenoid upon an iron plunger within it to be calculated, or at least that there is some obscure difficulty that prevents the design of such plunger electromagnets from being readily predetermined, so that when constructed they shall fulfill any prescribed specification as to the required pull and range of travel. The author has, however, not found much trouble in working out a set of rules for design which yield results of an accuracy quite comparable with that attained by the customary rules for the designing of electromagnets for dynamos and motors. It is believed that these will be welcomed by engineers interested in this branch of construction. Hence a brief account of them and of the principles on which they are established is here given.

To concentrate attention on the essentials of the problem consider a magnetic circuit constituted as shown in Fig. 1, where a cylin-

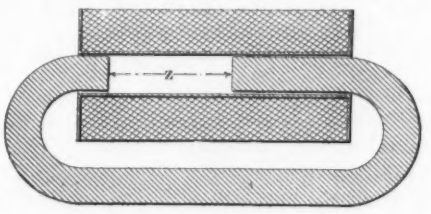


FIG. 1.—SECTION OF MAGNET AND BENT CORE.

drical rod of soft iron is supposed to be bent so that its ends enter a tubular bobbin carrying a magnetizing coil. Let the length of the gap between the ends of the rod be called z inches, and let the excitation be such that the flux density along the gap, which will be practically uniform, be B lines per square inch. Let each of the end faces of the iron have an area of A square inches. Then it is known that the pull along the gap z, tending to bring the two end faces of the iron together, is expressed by the formula

$$P = B^2A/72{,}134{,}000; \qquad (1)$$

where P is the pull in pounds weight. It is also known that the flux density, B, in the gap is related to the excitation according to the formula

$$B \times z \times 0.3133 = IS; \qquad (2)$$

where IS stands for the number of ampere-turns of excitation that are actually expended in driving the magnetism across the gap, and 0.3133 is the gap coefficient. If the iron is of good quality, and its magnetic state is far removed from saturation, the number of ampere-turns required to send the flux along the iron part of the magnetic circuit will be negligibly small compared with the number of those thus needed for the magnetism in the gap; and, therefore, the total number of ampere-turns of excitation to be provided by the exciting bobbin will not be sensibly greater than that expressed by the above formula. The symbol, I, stands for the current in amperes, the symbol S for the number of spirals or turns of wire on the bobbin. Hence we may take it that, under the above assumption, the iron is far from saturation, the actual ampere-turns needed will be $I \times S$. If the iron were so far saturated as to require a sensible additional number of ampere-turns for its magnetization, then the necessary total current would need to be slightly increased, or what comes to the same thing, the reluctance of the iron must be taken into account by adding a small equivalent length to x. In all the practical cases that arise, this increase to provide for the reluctance of the iron does not amount to more than about 2 per cent. of the whole; and may, therefore, be left out of account for most purposes. The gap coefficient, 0.3133, is only another expression for the reluctivity of air expressed in inch units.* In other words, to drive magnetism, with a flux density of one line per square inch, along a gap 1 in. long, requires 0.3133 of 1 ampere-turn.

Let us pass from the consideration of Fig. 1, in which nothing was movable, to the case presented by Fig. 2, of an iron-clad coil provided with a movable plunger, capable of being attracted in

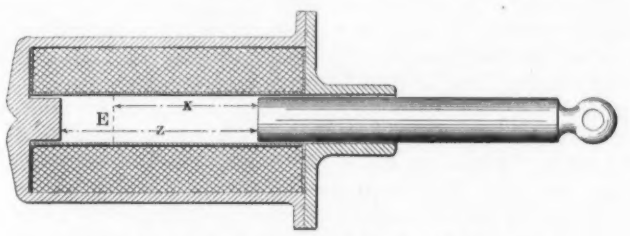


FIG. 2.—IRON-CLAD COIL WITH MOVABLE PLUNGER.

from the right, the iron jacket being extended at the ends so as to form on the right a sort of stuffing box (lined in practice with a thin tube of copper or brass) through which the plunger enters, and on the left a face plate, from which a short cylindrical piece enters the other end of the bobbin. The reluctance of the points may be taken as zero, provided they have surface enough. So then, again, if the iron is far from saturation the only reluctance that need be taken into account is that of the gap between the end of the plunger and that of the opposing iron piece. Now, let it be assumed, for reasons that will presently appear, that the plunger will not be permitted to travel so far down as actually to come in contact with this opposing iron piece, but that its movement will be stopped at some point a little farther to the right, such as that marked E. Then its range of motion will be from E to some point to the right. As in the figure, let its *range* of motion (or *stroke,* to use an engine term) be called x. Then it is clear that if any particular excitation by a given number of ampere-turns were provided, the pull would differ at different parts of the stroke, being a minimum when the plunger was at the beginning of its stroke. For, when at the beginning of its stroke, the length of the internal gap is a maximum, and the flux density will be a minimum, since from formula (2) we have: $B = IS/0.3133\ z$.

Now write $P_{max.}$ for the pull at the end of the stroke, where B is a maximum, and $P_{min.}$ for the minimum pull when B is at its minimum. The designer will generally be required to work between a given maximum and a given minimum pull. Thus, for example, he may be required to design an apparatus to give a maximum pull of 100 pounds and a minimum pull of 40 pounds, with a stroke of 2 in. Let the ratio of the maximum pull to the minimum pull be called y. Then, since, by formula (1), P varies as the square of B, we have:

$$y = P_{max.} / P_{min.} = B^2_{max.} / B^2_{min.}; \text{ whence, } \sqrt{y} = B_{max} / B_{min.}; \text{ and}$$

$$B_{min.} = B_{max.} \div \sqrt{y}.$$

Going back to formula (2), and writing it out for the two extreme cases, we have, at the beginning of the stroke, where the distance along the gap from iron to iron is at its maximum value, which we

*A paper presented at the International Electrical Congress of St. Louis, 1904.

*For those who prefer to work with metric units the formulæ will stand as follows:—

$$P \text{ in kilogrammes} = B^2A/24{,}700{,}000 \qquad (1a)$$

and

$$B \times z \times 0.795 = IS \qquad (2a)$$

where A is the area in square centimeters, B the flux-density in lines per square centimeter, and z the gap-length in centimeters. The numeric 24,700,000 is made up of 8π and 981,000, the latter being the number of dynes in the weight of 1 kg. The gap-coefficient 0.795 is the reciprocal of 0.4π.

will call z, $Bmin. \times z \times 0.3133 = IS$; and at the end of the stroke, when the gap is reduced to $z - x$, $B max. \times (z - x) \times 0.3133 = IS$. From this it follows that $z/(z - x) = B max. / B min. = \sqrt{y}$. Hence, z *must necessarily* have the value

$$z = \frac{\sqrt{y}}{\sqrt{y} - 1} \times x; \qquad (4)$$

and as y is the ratio of the specified maximum and minimum pulls, it is at once seen that, in order to calculate z from x this function of y becomes important. For convenience some values of it are here tabulated for reference. The ratio $\sqrt{y}/(\sqrt{y} - 1)$ is called u for brevity.

TABLE I.—FUNCTIONS FOR PULL RATIO y.

$y = P_{max.}/P_{min.}$ ..	10	1.5	2.0	2.5	3.0	3.5	4.0	5.0
$u = \sqrt{y}/(y-1)$ ..	∞	5.4	3.44	2.7	2.37	2.15	2.0	0.55
$1/u = 1 - 1/1\sqrt{y}$		0.185	0.29	0.37	0.42	0.465	0.5	0.55
$1/(\sqrt{y} - 1)$	∞	4.4	2.44	1.7	1.37	1.15	1.0	0.83

$y = P_{max.}/P_{min.}$	6.0	7.0	8.0	9.0	10.0	16.0	25.0	100.0
$u = \sqrt{y}/(\sqrt{y} = 1)$	1.69	1.60	1.55	1.5	1.47	1.33	1.2	1.11
$1/u = 1 - 1/1\sqrt{y}$.	0.59	0.625	0.645	0.666	0.68	0.75	0.8	0.9
$1/(\sqrt{y} - 1$	0.69	0.6	0.55	0.5	0.47	0.33	0.2	0.11

So far as the first two lines of the table are concerned, their use is exemplified as follows: Taking the instance of a design to have a pull varying from 40 pounds to 100 pounds with a stroke of 2 in., we have here $y = 100 \div 40 = 2.5$, and looking in the table we see the corresponding value of u is 2.7. This means that we must multiply the stroke by 2.7 to find z, which will, therefore, bee 5.4. In fact, unless we design the apparatus so that at the beginning of the stroke the reluctance of the magnetic circuit is 2.7 times as great as the reluctance is at the end of the stroke, we shall find that the minimum pull will drop to a less value than 1/2.5 of the minimum pull. It is obvious that, if the minimum pull is specified to come to a higher fraction of the maximum, the greater will be u.

Next, returning to formula (1), let us remember that if d be the diameter of the core, the area, A, of its end face will equal $d^2 \times 0.7854$. Hence we may immediately deduce the new rule that:

$$d = 9{,}580 \times \sqrt{P}_{min.} / B_{min.} \qquad (5)$$

This determines the diameter of the core if *Bmin.* has been fixed. Conversely, if d is given we can fix *Bmin.* as follows:

$$Bmin. = 9{,}580 \times \sqrt{P}_{min.} / d. \qquad (5a)$$

To get a new relation we may go back to formula (2), and inserting in it the value of *Bmin.* just obtained, and z is the total gap length, we find:

$$3{,}000 \times z \times \sqrt{P}_{min.} / d = IS. \qquad (6)$$

This enables us to calculate the required number of ampere-turns if the diameter of the core has been fixed. The rule is in itself of some practical interest, for it shows us that in any given case where the maximum and minimum pulls, and the stroke, are given, the necessary ampere-turns will vary inversely as the diameter chosen for the core. If we double, for example, the diameter of the core, making the plunger four times as heavy as before, the excitation may be reduced to one-half.

We are now ready to consider a number of trial values or alternative designs to fulfill any prescribed case. Using the same illustration as before, we will put down as being specified $P_{max.} = 100$ pounds; $P_{min.} = 40$ pounds; $x = 2$ in. We have already found $y = 2.5$, $u = 2.7$ and $z = 5.4$. We also know that $\sqrt{y} = 1.58$. Hence, by rule (3), $B_{min} = B_{max.} \div 1.58$. Also $\sqrt{P}_{min.} = 6.32$.

SCHEDULE OF TRIAL VALUES.

$B_{max.}$	100,000	80,000	60,000	50,000	40,000	30,000	20,000
$B_{min.}$	63,290	50,640	37,980	31,645	25,320	18,990	12,660
d	0.96	1.2	1.6	1.91	2.39	3.19	4.78
IS	107,000	85,600	63,600	53,500	42,800	31,800	21,400

We first put down some trial values of *Bmax.* and, dividing each by $\sqrt{y}$, we get corresponding values of *Bmin.* By formula (5) we then find the resulting values of d; and then IS follows either from (6) or from the rule

$$IS = B_{min.} \times z \times 0.3133. \qquad (2b)$$

On comparing together the values so set down, we see at once that if we attempt to work up to a maximum density of magnetic field in the gap as high as 100,000 lines per square inch, the plunger may have a diameter of only 0.96 in.; but then we should have to provide no fewer than 107,000 ampere-turns of excitation. And when we consider that on large multipolar dynamos the amount of excitation on one pole is generally of the order of 6,000 to 10,000 ampere-turns, or exceptionally rises to 20,000 in large alternators, we see that this design is impossible by reason of the copper required. On the other hand, if we reduce the maximum density to 20,000, the core diameter comes up to 4.78 in., and the ampere-turns fall to 21,400.

The considerations which will settle our choice between the various alternatives have yet to be laid down. It may be remarked that a different order of procedure might have been followed. Thus we might have taken as trial values for d, 1, 1½, 2, 3, 4 in., and calculated the corresponding values of *Bmin.* and thence *Bmax.* from formula (5*a*).

It is found in practice that the maximum pulls are given with great accuracy by the above rules, but that, owing to secondary causes, the minimum pulls are rather higher (in some cases several per cent.) than the calculated values.

We next enter on the thorny question of the length and depth of the magnetizing bobbin. Let us call the winding length between the bobbin cheeks, L, and the available winding depth, T. Also call the mean length of one turn M, then the sectional area of the whole winding is $L\,T$, and the winding volume is $M\,L\,T$. Also, if the actual permissible current density through the cross-section (not the current density in the copper only) in amperes per square inch be called β, obviously have the relation $L\,T \times \beta = IS$. So, if β is known from experience we get the rule

$$L\,T = IS/\beta \qquad (7)$$

Now experience shows that if proper pains are taken to give cooling surface, by radiating ribs or otherwise, β may be as great as 2,000 or 3,000 for coils that are used for momentary work—that is to say, for which the current is never kept on for more than 20 or 30 seconds at a time. For apparatus in which the current is kept on for as much as 10 minutes or more, much lower current densities must be used. The extreme case of prolonged user for several hours continuously involves either special cooling arrangements with internal ducts, or else the use of a very low density, such as $\beta = 300$ to 400. This is at best a rough way of reckoning; the more exact way is indicated later. If in cases for momentary user we assume $\beta = 2{,}000$, we can fix a provisional value for the winding area, $L\,T$. Now we have seen that the requirement that the minimum pull shall not fall below a definite fraction of the maximum pull involves the provision of a total length, z, of "equivalent gap," which is u times greater than the actual stroke. The greater u is the greater must the excitation be for a given maximum pull. Thus, for example, give a maximum pull of 12 pounds, using a core 1 in. in diameter, and with a stroke of 3 in., will require an excitation of 133,000 ampere-turns if the minimum pull is not to drop below 8 pounds; whereas it will only require 46,600 ampere-turns if the minimum is permitted to drop to 4 pounds, and only 4,080 if the minimum is permitted to drop to 1 pound at the beginning of the stroke. We have to pay a very heavy price in ampere-turns (that is, in copper, or in current, or both) for the attempt to keep up the minimum pull.

Suppose that the total winding area, $L\,T$, has been provisionally found, it remains to ascertain the separate values of L and T. This is again a matter where experience must to some extent guide. The total weight of copper (for a given number of ampere-turns) will be reduced if we make L very long and the depth, T, small, since then the mean length per turn is kept small. But L should obviously have *some* relation to the length of stroke, since it would be absurd to use a very long bobbin if only a short stroke is required, and a long stroke cannot be got if the bobbin is short. Here it must be remembered that in order to keep up the minimum pull at the beginning of the stroke we were forced to provide an addition to the gap, or, rather, to calculate the ampere-turns as if the gap length were z not x. A glance at Fig. 2 will make it clear that if for this reason the gap has had to be increased from x to z, the length, L, of the exciting bobbin cannot be less than z. For, if there is a good stuffing box or cylindrical collar at the right, we may reckon the beginning of the stroke as the point when the plunger actually begins to enter the windings, and at the other end there is no need to make the projecting iron piece enter farther than the thickness

of the bobbin cheek. Hence, unless in some special case this would lead to an undue heaping up of the coils, it is a useful guide to take for L provisionally the same value as was found for z. All this is under the assumption still that the solenoid is going to be jacketed with iron, so that the only sensible reluctance in the magnetic circuit is that of the internal gap. If now we take equation (7) and insert in it the value of IS given in equation (6) we get

$$T = \frac{3{,}000}{\beta} \times \frac{\sqrt{P}_{min.}}{d} \times \frac{z}{L}. \qquad (8)$$

And if we assume as above that β may be as great as 2,000 (for cases of apparatus used only for a few seconds at a time), and that $L = z$, the rule becomes

$$T = 1.5 \times \sqrt{P}_{min.}/d \quad . \quad . \quad . \quad . \quad (9)$$

Let us see how this works out in the example previously used. The minimum pull was 40 pounds, so $\sqrt{P}_{min.} = 6.32$ and z was 5.4 in. If we had used a plunger 2 in. in diameter, the exciting bobbin would have the following dimensions: L = at least 5.4 in., T = at least 4.74 in. This, allowing ¼ in. for the tubular part of the bobbin, would imply an exciting coil the inner diameter of which was 2.25 and the outer diameter 11.73 in. If, instead, a plunger 4 in. in diameter had been used, formula (9) shows that T would be reduced to 2.37 in., and the inner and outer diameters of the coil would become 4.25 in. and 8.99 in., respectively.

Another approximate way of estimating the length, L, of the exciting bobbin is to draw upon experience, which shows that if T is not more than, say, 3 in., and due care is taken as to cooling, each inch length of tubular coil can carry from 3,000 to 10,000 ampere-turns, the lower number being appropriate for cases of continuous service, the higher for cases of momentary service only. Now, this gives us a means of judging which of the trial values previously set out should be selected, for, since on $B_{min.}$ depends the number of ampere-turns needed, it must not be taken too high. If we apply these considerations to formula (2) we find at once that, in apparatus for prolonged work, $B_{min.}$ must not exceed 9,580; while in that for momentary use $B_{min.}$ may be taken at 16,000 or 20,000, or even up to 38,000 in those cases where there is no danger of $B_{max.}$ rising over 100,000. To find the mean length of one turn, M, on the supposition that the thickness of the tubular walls of the bobbin and the internal clearance add 0.25 in. to the diameter, the formula is

$$M = \pi\ (0.25 + d + T). \qquad (10)$$

So far we have considered the excitation simply as so many ampere-turns, regardless of the separate values to be assigned to the amperes and the turns, and regardless of the resistance of the coil or of the watts wasted in it as heat. Now, as the rules pertaining to these matters are in no way different from those of ordinary electromagnets they may be here treated as briefly as possible by merely quoting those that will be found most useful. The symbols used are as follows:

α = ampere-density in the copper section.
β = ampere-density in the gross winding space.
δ = diameter (bare) of wire in inches.
δ_1 = diameter (covered) of wire in inches.
R = resistance of coil in ohms.
r_1 = resistance of wire per inch in ohms.
ρ_1 = resistance per cubic inch of coil space.
s = sectional area of wire in space inches.
σ = space factor = copper area ÷ gross area.
V = voltage applied to terminals of coil.
ω = watts consumed = $IV = I^2R$.

If I is prescribed, $IS \div I = S$; $\beta = IS \div LT$; $\rho_1 = \alpha\beta \times 0.8/D^2 \times 10^6$, which fixes the gauge of the wire; $s = I \div \alpha$; $V = \omega \div I$.

If V is prescribed, $I = \omega \div V$; $r_1 = V/M \times IS$, which fixes the gauge of the wire, or 12,000 $V/M \times IS$ = resistance per 1,000 ft.;

$$\delta = \frac{1}{1{,}000}\sqrt{\frac{M \times IS}{V}};$$

$$s = \frac{IS \times M}{V} \times \frac{0.8}{10^6}.$$

The following are also useful: $\sigma = 0.785 \times \delta^2 \div \delta_1^2$; $LT = S \times s \div \sigma$; $M = 420 \times d \times \omega/a \times z \times \sqrt{P}_{min}$

Example.—An example will make the process clearer. The case taken is an iron-clad coil to give a pull of 10 pounds, increasing to 30 pounds, over a range of 1 in. Voltage of supply, 100 volts for intermittent work. Here $P_{max.} = 30$; $P_{min.} = 10$; $x = 1$; $y = 3$; $\sqrt{y} = 1.732$; u (see Table I) $= 2.37$; $z = 2.37$; $\sqrt{P}_{min.} = 3.16$.

$IS \times d = 3{,}000 \times 2.37 \times 3.16 = 22{,}500$, by formula (6).

$B_{min.} \times d = 9{,}580 \times 3.16 = 30{,}300$, by formula (5).

$B_{max.} = B_{min.} \times \sqrt{y}$, by formula (3).

TRIAL VALUES.

d	0.5	1.0	1.5	2.0
IS	45,000	22,500	15,000	11,250
B_{min}	60,600	30,300	20,200	15,150
$B_{max.}$	104,800	52,400	34,930	26,200

The first of these requires too many ampere-turns for so small an apparatus. To judge of the merits of the designs we calculate them out, assuming that β may be taken as high as 20,000, so that $LT = IS \div 2{,}000$. If the space factor is taken at 0.5, this implies that the current density in the copper will be α = 4,000 amperes per square inch.

TRIAL VALUES.

L	7.5	3.75	3.0	2.82
LT	22.5	11.25	7.5	5.625
T	3.0	3.0	2.5	2.0
M	11.8	13.4	13.4	13.4
LTM	266.0	151.0	101.0	75.5
δ	0.0739	0.0550	0.0450	0.0389
s	0.00434	0.00242	0.00161	0.00121
I	17.36	8.68	6.44	4.84
S	2.600	2.325	2.325	2.327
w	1.736	.868	.644	.484
Lbs. of copper	42.3	24.0	16.0	12.0
Wt. of plunger	0.6	1.53	3.05	5.2

The last of these designs is the cheapest, and wastes less pow r than the others; but if the weight of the iron jacket is included it will be rather heavier than the third design.

In calculating the length, L, in the above example, it was assumed that T must, for reasons of heating, not exceed 3 in., and this assumption caused L to be greater than z, as it must in many cases be. For if the whole coil is taken as short as z, then the coils may pile up to too great a thickness, and with the increase in the mean length of one turn will come a great weight of copper, and, what is also bad, the cooling surface will be insufficient. The relation between watts expended and necessary cooling surface cannot be stated with any precision, because of the intermittent nature of the user of the apparatus. But, taking the watt consumption during the periods of use, and averaging it out over an hour, if the average consumption came to more than 3 watts per square inch of cooling surface the design ought to be reconsidered to give more cooling surface. Even so, the temperature rise will exceed that permitted in dynamos and motors. Lengthening the coil always is advantageous from this point of view, for it not only increases the surface but reduces the mean length of the turn and, for a given permissible watt consumption, reduces the weight of copper; or for a given weight of copper it reduces the watt consumption.

Incompletely Inclosed Coils.—So far as we have assumed an iron-clad type of coil, and we have found that, in order to fulfill the specified conditions of the minimum pull at the beginning of the stroke not falling below a certain fraction of the final pull, it was necessary to make z, the length of the equivalent gap at the beginning of the stroke, longer than the length, x, of the stroke itself. In other words, there was left in Fig. 2 a space between the bottom of the plunger, when it reached the end of its stroke at E, and the end of the iron piece which closed the tube. In engineers' language a clearance was left at the end of the cylinder below the piston. This clearance space might be filled up with brass or any other non-magnetic material so far as the reasoning was concerned. It might be thought that this space simply wasted power by requiring more ampere-turns to drive the magnetism through it. But the part it plays is best seen by considering what would occur if it were not there. Suppose it to be filled up with iron. Then when the plunger is right up to E there would clearly be required very few ampere-turns to give the maximum pull. If the excitation were reduced accordingly, then, when the plunger was again pulled out to the top of its stroke, there would be so little excitation that the pull would fall far below the required minimum. So, then, it is absolutely necessary that when the plunger is at the bottom of its stroke, and the pull is a maximum, there should be this additional gap or its equivalent. Now that equivalent may be attained in another way—viz.: if an equal amount of reluctance is introduced into the circuit

at some other part. Let the point, E, the bottom of the stroke, be shifted right to the end of the coil (on the left). Then a gap in the magnetic circuit can be obtained by removing the iron face plate at the end, or as much of it as may be needed to produce an equivalent reluctance. Suppose we were dealing with the case where *Pmax.* is four times *Pmin.*, or where the pull ratio, $y = 4$. Reference to Table I shows that in this case $u = 2$ or $z = 2x$. If we removed the end shield this would possibly not sufficiently increase the reluctance—it might be necessary to cut off some of the external jacket also. The amount would depend on the shape of the whole coil. If the whole cylindrical space down the tube were long compared with its diameter, the reluctance from end to end through the interior would be great compared with the reluctance of all the possible paths through the external air if the jacket had been entirely removed. Hence removing the jacket in such a case would not double, but would only slightly increase, the total reluctance existing when the plunger is in the position of beginning the stroke.

The principle of magnetic images will help toward an understanding of the matters involved. In a paper read by the author before the Electrical Congress at Como in 1900, it was shown, and experimented proofs were adduced confirming the theory, that if a sheet of iron of indefinitely great permeability compared with air, and of indefinitely large size, were placed beyond the end of a solenoid, the effect of its presence is precisely that of a *magnetic mirror.* At all points of the space in front of it the effect of its presence is the same as would be produced by the presence of a second solenoid of equal power situated behind the mirror at the place where, optically speaking, the virtual image of the first solenoid would be situated. If placed hard up against the end of the solenoid the effect is to double the length of the solenoid. If two such "mirrors" are placed against the two ends of a solenoid of finite length, they have the same effect as making the solenoid of infinite length.

Now it is known that the strength of the field (in c.g.s. units) at any point inside an indefinitely long, uniform solenoid is given by the expression, $H = 4\pi IS/10l$, l being in centimeters. The corresponding expression in inch units is $H_1 = IS/l \times 0.3133$. These values are true to within 1 per cent. for the field at the mid length of the solenoid, provided its length be not less than six times its internal diameter. The value of the field at the mouth of the solenoid is exactly half this value, as is at once seen by considering that the effect at the middle must be equally due to that part of the solenoid which lies to the right and to that which lies to the left. The effect of putting an iron sheet or end plate across the end of an unjacketed solenoid is then (assuming the iron to be of indefinitely great permeability and extent) to bring up the value of the field within the mouth to the same amount as it would have if the solenoid were indefinitely extended and had the same number of ampere-turns per unit of length.

Consider by the light of this fact what is the effect of putting on an iron face plate with a well-fitting iron stuffing box on the anterior end of the solenoid. Saying that it will have a permeability and an extent less than infinite, the effect of its presence is that, when the plunger is in the initial position just beginning to enter the coil, the field at that end of the tube is brought up to the same strength that it has at the middle. Now, even without such an end-plate, the extended long plunger performs partially the same function. If it were a perfect performer it would be pulled in this position with an initial pull corresponding to the magnetic tension along that field, and this, even with a long solenoid and as many as 2,000 ampere-turns per inch, would scarcely be as much as ½ pound per square inch of end surface of the plunger. Once entered, however, into the mouth of the coil the plunger experiences a pull which steadily increases—supposing the plunger to be at least a little longer than the coil—until its advancing end reaches the bottom of the coil, where the pull is a maximum. And this maximum is seen, by reasoning analogous to that used above, to be equal to one-quarter of the pull there would be between this plunger and its image if an iron mirror were placed against the bottom of the coil. What that pull would be will depend on the permeability of the iron as well as on the ampere-turns per unit of length that magnetize it and on its area of section. If the permeability is known, or its curve has been ascertained, B can be found from the curve; and the pull will be one-quarter of that calculated by equation (1). Hence it is the permeability of the iron as well as its section which determines the maximum pull of an unjacketed coil upon the plunger. In the iron-clad coil it is the permeability of air in the gap (or in the equivalent gap) which determines the maximum pull; since, as experience shows, and as can be foreseen from the equations, those designs in which the plunger is of so small a diameter that saturation approaches a point where the reluctance of the iron need be taken into account, are more costly than those where the iron saturation is kept low.

Adaptation of the calculations to cases of coned plungers is reserved for a future publication, the present communication being confined to cylindrical plungers.

The Chicago Telephone Company's "Juice Wagon."

For several winters past the Chicago Telephone Company has had some trouble caused by the freezing of water in the iron pipes in which its lead-covered cables are run from the conduit to the pole. These branches from the conduit line to the pole line are commonly called "laterals." Last winter being unusually cold, an unusual amount of trouble was experienced. In order to understand the situation, a sketch is given of the typical arrangement which was until recently used where cables were to be taken from an underground to an overhead line. In this sketch, Fig. 1, it is seen

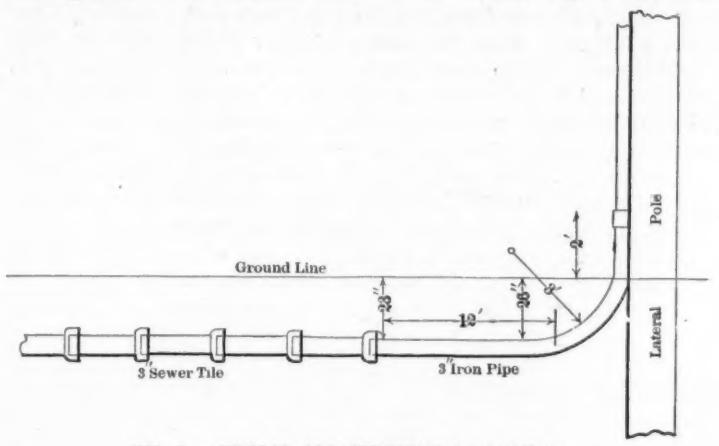


FIG. 1.—TYPICAL ARRANGEMENT OF LATERAL.

that after the cable leaves the tile conduit it is taken in an iron pipe. This iron pipe was formerly placed so that a length of about 12 ft. of straight pipe was laid horizontally in the earth and about 2 ft. extended above the surface of the ground, where it connected to another length running up the pole. The bend had a radius of about 3 ft. The placing of the 12-ft. end of the iron pipe in the ground was not according to any definite instructions given the construction force, but the men seem to have drifted into this way of doing things, to avoid cutting a length of pipe which would otherwise have been necessary. If the 12-ft. end was placed up the pole less than another full length of pipe would be needed to extend it to the required height; therefore, the long end was laid in the ground and the short end was put up the pole. The iron pipe was 3 in. in diameter and frequently would be lower at the pole than at the tile connection. In every case where there was trouble from freezing the trouble occurred where the cable lay in the iron pipe. The water in freezing would expand so as to crush the lead-covered cable and short-circuit some of the paper-insulated wires. Although both the iron pipe and the tile might be filled with water and frozen solid, there was no trouble where the cable lay in the tile. In whatever way this may be accounted for in theory, the facts remain the same.

The trouble has bothered the company more or less for several years past, reaching a maximum last winter, which was very cold, frost having gone into the ground in places as deep as 4½ ft. There was considerable snow, and this disappeared by melting, several times, so that the manholes were flooded and the water backed up into the conduits, where it remained in undrained dips until frozen.

In Figs. 2 and 3 are shown pieces of some of the cables taken out of laterals which have been frozen up. In Fig. 3 a mirror has been placed so that the ends of some of the cables can be seen. The cables are crushed in several different ways. Some are simply flattened and others are caved in at one side, forming a crescent.

The thawing out of these laterals was a very difficult and expensive operation. The old method is shown in Fig. 4. A city fire

engine would be hired at $5 per hour to furnish live steam. This would be introduced by a steam jet into the cable conduit and the jet would gradually be forced in as fast as the thawing of the ice would permit. This would take from 12 to 36 hours. This, of course, necessitated also the destruction of the cable, because there was not room for the jet alongside of the cable. The only other way to overcome the difficulty was to dig up the whole lateral.

The severity of last winter caused so much trouble from the

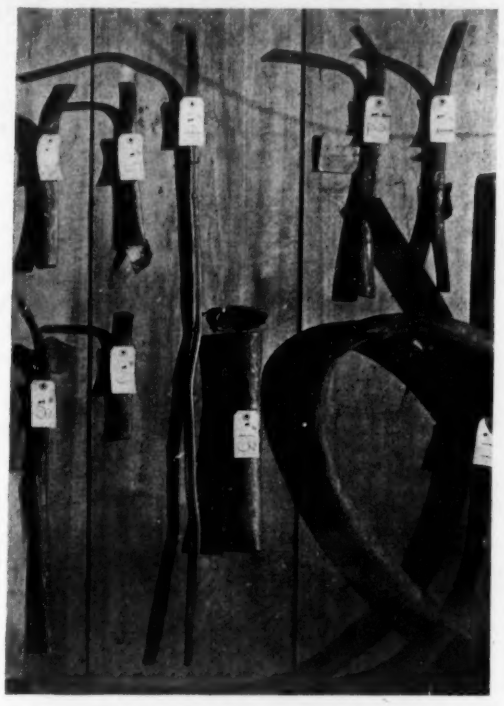


FIG. 2.—CABLES CRUSHED BY FREEZING.

freezing that Mr. R. S. Peirce, who has charge of the construction department of the Chicago Telephone Company, began to consider the advisability of thawing out these laterals electrically, something after the manner of thawing out frozen water pipes. The company accordingly constructed what now goes by the familiar name of the "juice wagon," for the purpose of supplying current to thaw out these laterals. The carrying out of this idea was entrusted to Mr. J. M. Humiston, then of the construction department, now with McMeen & Miller.

Figs. 5 and 6 show the "juice wagon" as finally completed. This wagon has a very heavy truck, on which is mounted four 15-kw transformers, of the ordinary type used on the lighting circuits of the Commonwealth Electric Company in Chicago, having primary coils wound for 2,080 volts, with 115-volt secondaries. These transformers are connected to the mains of the Commonwealth Electric Company by an employe of that corporation wherever the "juice wagon" may be needed. The other members of the crew going out with the wagon are Chicago Telephone Company employes. In one case a temporary pole line 400 ft. long was constructed of ladders for the 2,080-volt connection. The transformers are arranged so that the primary coils can be connected four in series, two in series and two in multiple, or four in multiple. The secondaries are permanently connected in parallel. Fig. 7 shows the different combinations in which the primary circuits of the transformers can be connected, while Fig. 8 is a diagram of the switch connections, the connections being altered by double-throw knife switches. The connections of the secondary circuits are shown in Fig. 9. It will be seen that an ammeter operated from a series transformer is placed in the secondary leads, also an impedance or choke coil for the purpose of cutting down the current in the secondary where it is desirable to do this without changing the primary connections. For connecting to the work, the wagon carries seven pieces of insulated copper cable in 100-ft. lengths, with plug connectors; the cable having a section of 211,000 circular mils.

The "juice wagon" complete weighs about 8,000 pounds. The rated capacity of the transformers is, of course, about 700 amp., with secondaries connected as they are in parallel. To thaw out a frozen lateral, the secondary leads are connected to the lead sheath of the cable which is in trouble. Connection is made through clamps about 18 in. long which surround the sheath, Fig. 10.

The first cables thawed out in this way were cut off in the vault and at the top of the iron pipe before the thawing-out current was applied. This was done because it was at that time supposed that a frozen up cable was ruined anyway, so that it would have to be taken out after thawing; and that the cutting was advisable to prevent any possible damage to the remainder of the cable plant by the heating caused by leakage currents, or interference with the service by induction during the thawing-out process. After the damaged cable had been thawed out it was pulled out and a new cable was put in its place and spliced in. Later it was discovered that usually a cable thawed out electrically is not ruined, and that it is even unnecessary to disconnect it. It is found that cables treated in this way, if thawed quickly enough after they are frozen, will clear themselves of short-circuits by the elasticity of the paper insulation. In other words, the process is not only much cheaper than the use of steam as a means of thawing out the cable, but it in many cases saves the cable itself and does not involve pulling in a new cable as a substitute for the old one.

The trouble makes itself known gradually by the short-circuiting of one or two pairs in a cable. If the cable is not thawed out quickly the compression by freezing becomes general and more pairs are short-circuited. The discovery that freezing and temporary short-circuiting of a cable does not necessarily injure it permanently was made by an experiment carried on at the company's storage yards. A piece of cable was laid in a bend of iron pipe similar to that used in lateral construction. The pipe was filled with water and the water frozen. The cable was compressed by the ice and some of the pairs were short-circuited. The ice was then melted from around the cable and the pairs which had been short-circuited by the freezing were found to be clear. Thus the fact was brought out that cables might be cleared by simply thawing away the ice which was crushing them. Since this discovery it has not been the practice to disconnect or disturb the cable in any way in order to thaw it out. After the connection of the cable has been made at the pole and in the nearest manhole, current is turned on, and if a sufficient volume of current is passed through the cable sheath it will soon be

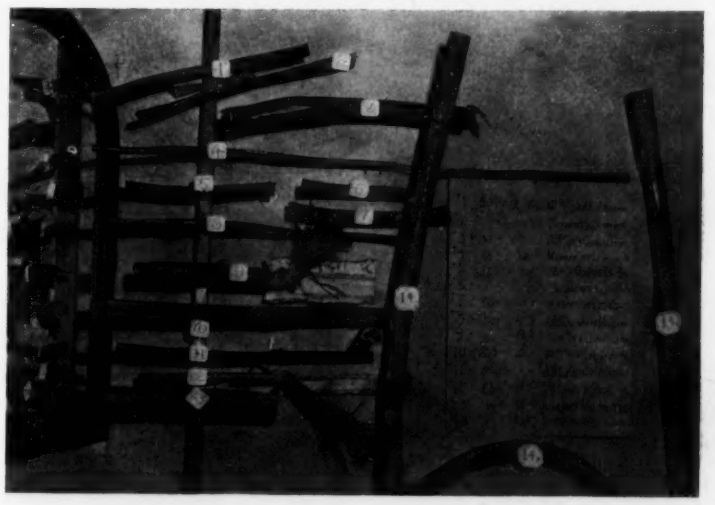


FIG. 3.—CABLES CRUSHED BY FREEZING.

thawed out. The current required depends of course on the cross-section of the lead sheath of the cable to be thawed out; on the amount of ice that surrounds the cable, and on the shunting action of the iron pipe and earth. The voltage depends on the length of cable to be thawed out. In looking over a list of 40 cases where cables were thawed out last winter by this method, it was seen that the kilowatt-hours taken vary all the way from 308 in one case to 10 in another. In only four cases did the energy exceed 100 kw-hours. Where the largest amount of energy was required it was usually necessary to do some special work thawing out the iron pipe after the cable had been withdrawn.

In order to give an idea of the conditions, a specific example will be taken. This case, by the way, happened to be one of the first attempts and hence some things were done that would not have been done with riper experience. Fig. 11 shows the situation at

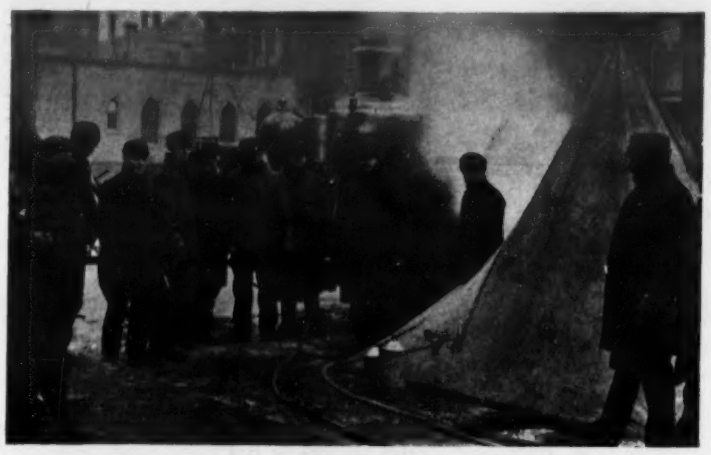


FIG. 4.—THAWING OUT LATERALS—THE OLD WAY.

FIG. 6.—"JUICE WAGON" IN OPERATION.

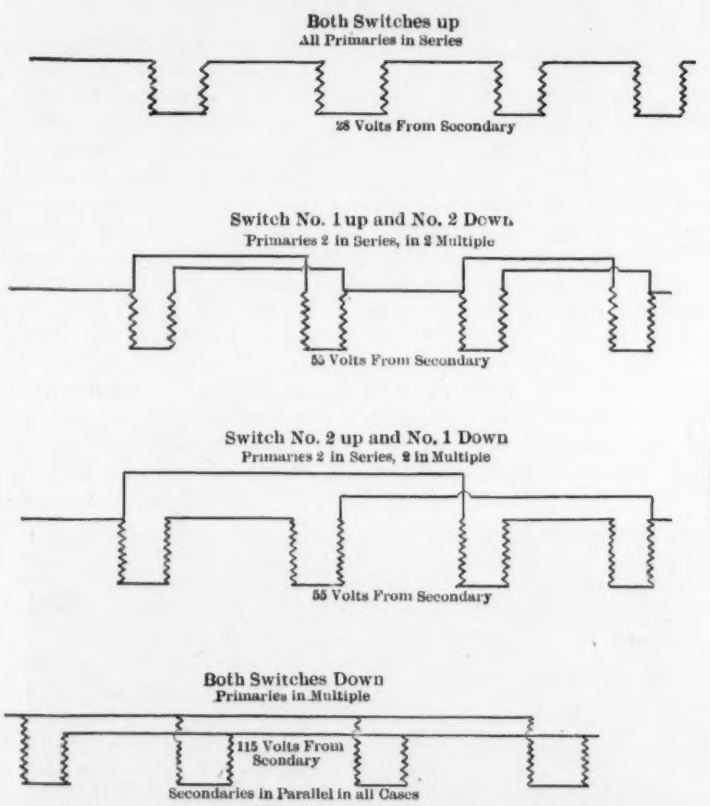

Both Switches up
All Primaries in Series
28 Volts From Secondary
Switch No. 1 up and No. 2 Down
Primaries 2 in Series, in 2 Multiple
55 Volts From Secondary
Switch No. 2 up and No. 1 Down
Primaries 2 in Series, 2 in Multiple
55 Volts From Secondary
Both Switches Down
Primaries in Multiple
115 Volts From Scondary
Secondaries in Parallel in all Cases

FIG. 7.—DIAGRAM OF TRANSFORMER PRIMARY CIRCUIT COMBINATIONS.

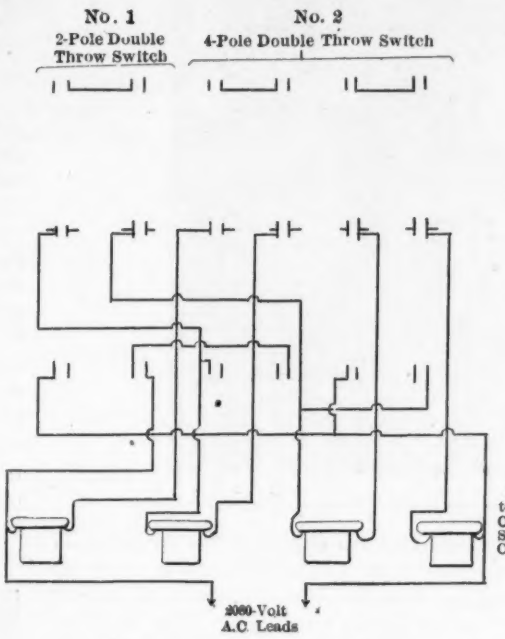


FIG. 8.—SWITCHBOARD FOR CHANGING COMBINATIONS.

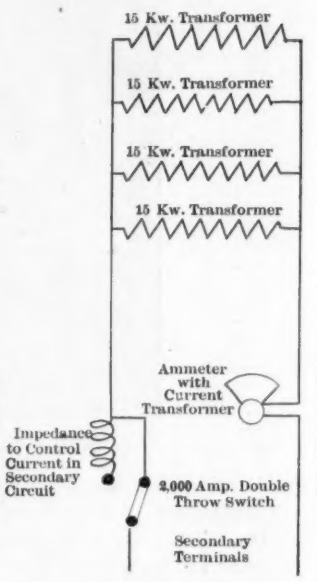


FIG. 9.—SHOWING CONNECTIONS OF TRANSFORMER SECONDARIES IN ALL CASES.

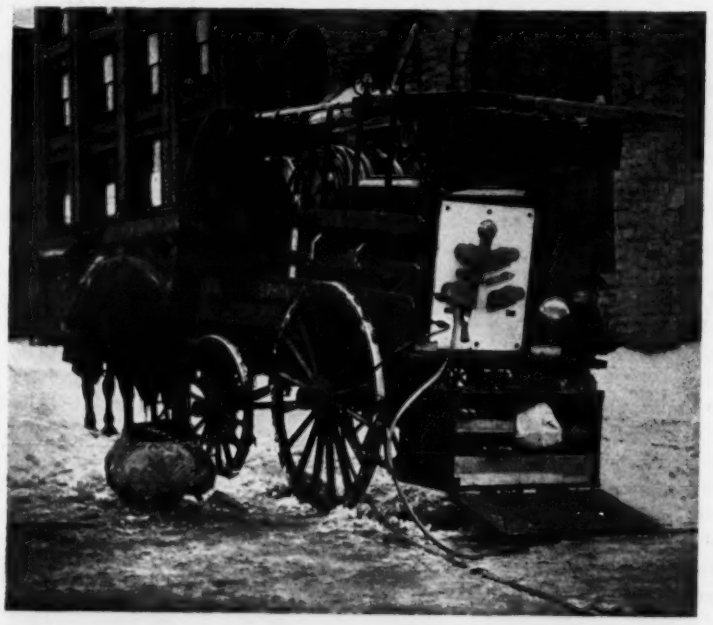


FIG. 5.—THE "JUICE WAGON."

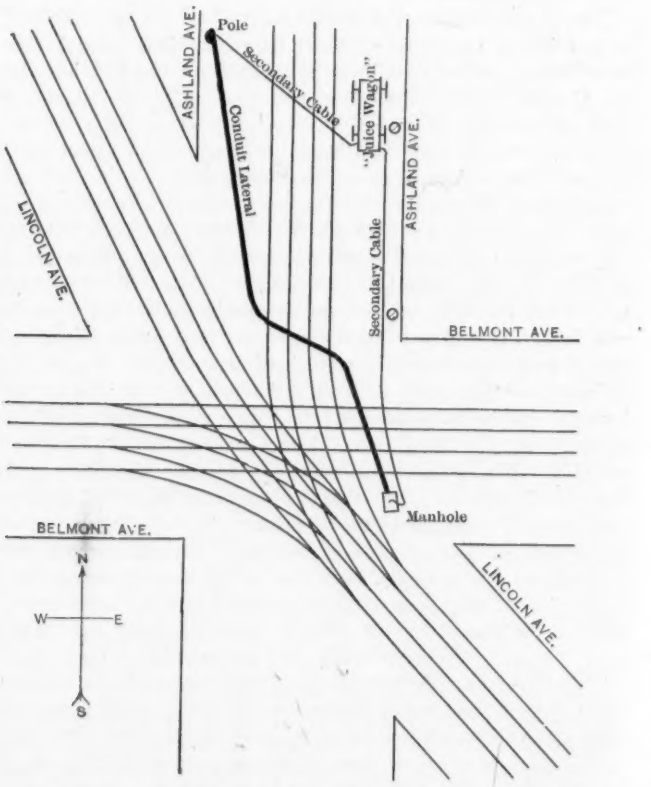


FIG. 11—EXAMPLE OF THAWING OUT LONG LATERAL AT CHICAGO.

Belmont, Ashland and Lincoln Avenues, Chicago. From the manhole on the southeast corner to the pole is a lateral 315 ft. long. The lead cable sheath was 1 1/16 in. in diameter and 3/32 in. thick. Connection was made to the cable sheath in the manhole and at the pole, the "juice wagon" being located as indicated. The transformers were connected to give 25 volts. This voltage resulted in a current of 115 amp., which was kept on for 1½ hours. This failed to do anything to loosen the cable. The transformer connections were then changed so that 230 amp. at 55 volts was obtained. After this current had been on for 30 minutes the ice was melted suffi-

FIG. 10.—CLAMP FOR CONNECTION TO CABLE SHEATH.

ciently to pull out the cable. On pulling in the new cable obstacles were met and it was found to be necessary to do something toward thawing out the ice remaining in the pipe. An excavation was made on either side of the car track and connections were effected to the iron pipe so as to include the two bends and the piece under the car track in the circuit, or about 30 ft. of 3-in. iron pipe. To thaw out this pipe 2,500 amp. was passed for 20 minutes with 28 volts pressure. About ¼ cu. ft. of ice came out of the pipe.

That the expense is small compared with thawing out with a fire engine at $5 an hour for 12 to 36 hours goes without saying. Not

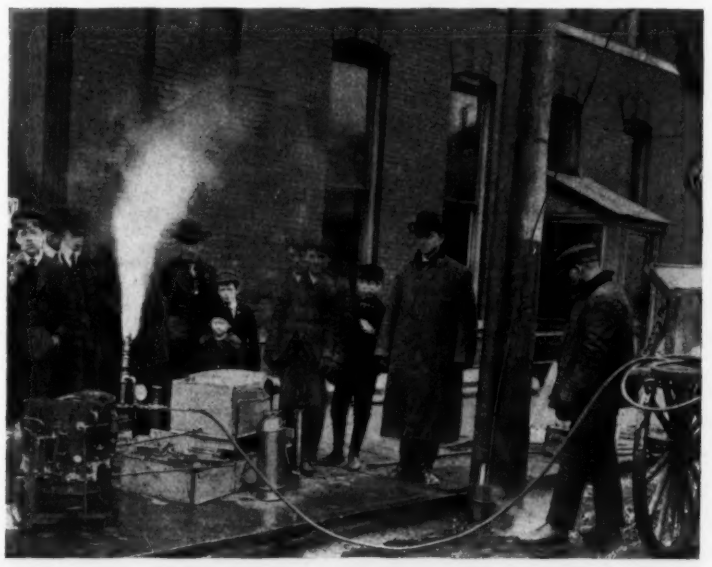


FIG. 12.—AUTOMOBILE BOILER FOR THAWING OUT LATERALS.

only is the time and labor required much reduced, but the cable is not ruined, and the interruption to the service is but a small fraction of what it was formerly. Since the "juice wagon" was built an automobile steam boiler has been fitted up for thawing in the old way where electric current is not available. This furnishes plenty of steam for the purpose and costs much less to operate than a fire engine, as it is worked by a company crew.

This trouble from freezing will probably not be experienced with any of the company's recently constructed laterals, as the new laterals are all made with sewer-tile bends, which bring the cable to the pole. Iron pipe will of course be used on the pole itself, but the top of the pipe will be made water-tight as far as possible to prevent water running into the pipe. Drip bends have also been put on the cables at the top of the pipes. The difficulty that has been experienced is a peculiar one, because it would be thought that the freezing would be as troublesome in the sewer pipe as in the iron pipe, but such is not the case. At any rate, it is worth knowing: first, that the company has hit upon an economical method of thawing out frozen laterals; and second, that trouble from frozen laterals can be avoided by a change in construction. The trouble is most pronounced with small cables, although large ones are by no means exempt.

The Cost of Telephone Service in a Farming Community.

BY H. SPRAGUE.

AMONG the problems which are to-day being worked out in the field of commercial telephony few are of greater interest than that of service in farming communities. It would be idle to prove that the telephone has come to be an almost indispensable adjunct to the farm located in the vicinity of an important town or village, because the rapid development of this phase of the business in the past five years is sufficient demonstration in itself of the usefulness of what is in some respects the most wonderful of all the great electrical inventions. Accustomed as the world is getting to be to its use of electric light and power, it has not yet lost the faculty of admiration for the apparatus which links together in instantaneous communication cities and towns nearly 2,000 miles apart. Even the trained telephone engineer, whose life is passed amid the intricate maze of relays, repeating coils, switchboard circuits, line, construction and traffic problems which have grown out of the simple appliances of twenty-five years ago, does not lose his appreciation of the laws which constitute the corner-stone of his exacting profession. This being so, it is no wonder that the progressive farmer has caught the enthusiasm of civilization, and by becoming a telephone subscriber has annihilated the isolation which for so many centuries has been the most striking characteristic of rural life.

The advantages of the telephone in farm life have been pretty thoroughly discussed within recent years in the technical, daily and secular press as a whole. Telephone men used little stimulation in this direction, and the peaceful campaign against the prejudice and inertia of possible subscribers is being waged with unlimited perseverance. An enormous field remains to be tilled, however, and the excellent motto, "A telephone in every home," is still a long way from being realized. Until this is accomplished the solicitor's employment is assured.

Although the technical problems of telephony have been widely published from time to time, very little has appeared in the professional journals regarding the actual cost of operation in farming communities. For this reason the writer believes that some figures drawn from American practice will be of general interest, although he regrets the necessity of withholding the name of the company and town from which the data was secured. The added interest of stating the specific property analyzed is recognized, but it is believed that the suggestiveness of the data will in no way be impaired by the necessity of leaving it without a local habitation and its real name.

A few months ago the company operating in the region to be discussed—which we may call Melville for convenience—desired to find out exactly what the service to farmers on a certain typical group of lines was costing. This group of lines, as shown in the accompanying diagram (Fig. 1), serves a farming territory lying to the northeast of the town of Melville, the telephone farthest away from the central office being about 17 miles from town. Cross arm construction is in use on the main lines, branches to groups of half a dozen or so telephones being carried in a single two-wire bracketed line. The district is in one of the most prosperous farming regions of the State in which it is located; it is fairly level or rolling country, supplied with good roads, and the telephone equipment and service compare favorably with the best to be found in rural communities. Toll connections are available at the central office with several other exchanges owned by the company, 94 per cent. of the

telephones on this special group being equipped for long-distance conversation. Metallic circuits are used throughout the entire group of lines, with galvanized-iron overhead wire, No. 14 in size, the poles for the most part being cedar and the central office switchboard being of the magneto type. The last half mile of the lead is carried in aerial cable to the central office. In the following paragraphs the group lines under analysis will be called the "East Melville leads."

The operating records of the company showed the data for obtaining the annual cost of service in the entire Melville district, but as this service was divided between many business and residence telephones in the center of the town in addition to the farmers' lines outside the more populous section of the community, it was at once realized that deductions from the total district would not solve the problem. After a careful study of the situation, the company decided to pro-rate the operating expenses of the East Melville lead on the basis of the calls originating upon the lead during a period of one month, compared with the total number of calls originating in the entire Melville exchange. This involved a traffic count of one month's duration at the central office switchboard, and as there was no further time available to devote to the carrying on of the count of calls, the month's average was taken as representative of the daily traffic, and the total for thirty-one days was multiplied by 12 to get the approximate annual volume of local business. The percentage of the total calls represented by the number of calls on the East Melville lead was then multiplied into the operating expenses

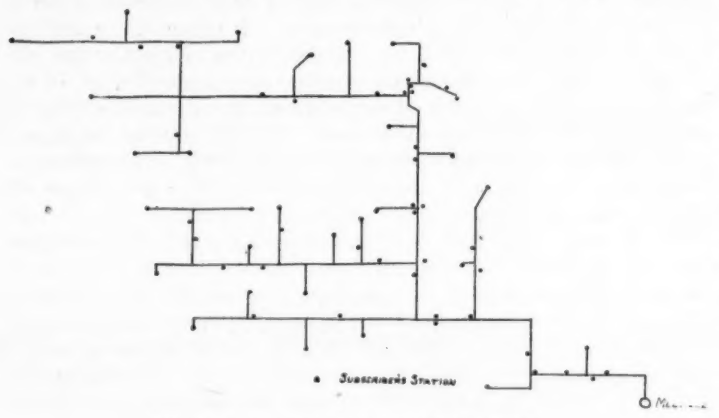


DIAGRAM OF GROUP OF FARMERS' LINES.

of the central office, in order to obtain the central office expenses of the East Melville lead itself. Maintenance expenses were obtained from the records of the line foreman in charge of the lead during the month; general expenses were drawn from the company's records and reduced to a unit basis, the unit being the subscriber's station; taxes were added separately after being pro-rated according to the relative number of East Melville instruments and those in the entire exchange; interest was figured at 6 per cent. on the investment, and depreciation taken at 10 per cent. on subscribers' station and pole line equipment, 5 per cent. on wire plant, and 7 per cent. on central office equipment. The general expenses included salaries and wages of the management and their related subordinates; rent, light and heat in the executive offices; postage, printing, stationery, directory and legal expenses, with incidentals. The operating expenses of the central office included salaries of local operators, rent, light and heat and the superintendent's salary, all these being pro-rated on the traffic count between the East Melville and the total exchange group of subscribers.

The average number of subscribers connected with the Melville central office during the month in question was 442. Of these 68, or 15.4 per cent., were located on the East Melville lead and were connected with the central office by 11 separate metallic circuits aggregating 256.8 miles of wire, exclusive of drop leads and house wiring at subscribers' stations and the half mile of aerial cable run in the center of the town. Three of the telephones on the East Melville lead were business instruments paying $4 per month for service; four of the farmers' stations paid $2 per month, and the remaining 61 paid $2.50 per month each. Records of toll business were kept as a matter of interest, but each originating toll call within the exchange was counted as a local originating call, inasmuch as it always had to be handled at the local operators' positions before being switched over to the small toll board which stood in the same room at the central office. The office is equipped with three toll booths, but these were not charged in with the local equipment. No insurance was figured on the East Melville lead or the central office apparatus.

As the records of the construction department were not segregated sufficiently to enable the investment cost of the East Melville lead to be obtained it was necessary to make a careful inventory of the poles, wires and instruments upon the ground and in actual operation. This involved about 150 miles of driving about the region and required about a week's time for its completion. The expense of this work, including livery, the salary of the engineer who performed it, and hotel expenses amounted to about $60, or about 88 cents per subscriber's station inventoried. The writer mentions this point as an instance of the value of having complete records of construction work, so that when data of this sort are wanted a reference to the files will supply it in place of sending a salaried man into the field for the information. As may be seen by the following summary of the inventory of the East Melville lead, an enormous amount of detail work was necessary to estimate closely the quantity of wire, staples, tie wire, line wire, insulators, cross arms, braces, poles, pins, etc., upon the approximate 50 miles of roadway covered by the lead. Considerable economy in the cost of the work was secured by taking care to begin at the proper end of a branch and double upon the track as little as possible. In one instance a drive of 9 miles was saved by doing this and cutting across country at the east end of the branch. The visit inside each farmhouse which the work required was an opportunity for a sociologist and a study in human and dog nature, which has no place in this paper. The approximate cost of the East Melville lead is shown as follows, with the inventory summary:

SUBSCRIBERS' STATIONS.

65	Backboards and battery boxes, at $3.15	$204.75
3	Battery boxes, at 35 cents	1.05
68	Bells with generator, switch hook, etc.	427.80
196	Blue Bell dry cells, at 13½ cents	26.50
3	Desk stands, at $3.10	9.30
68	Receiver cords, at 10 cents	6.80
1792	Feet No. 19 B. & S. office wire, twisted pair	17.20
1362	Feet No. 18 B. & S. annunciator wire, single	1.89
7993	Feet No. 14 insulated iron wire	27.30
8401	Feet No. 14 bare iron wire	6.10
130	Porcelain knobs	.72
6	Glass knobs	.06
32	Anti-hummers	3.20
9	25 ft. spruce poles (f.o.b. Melville)	22.95
69	Ground rods	9.52
68	Lightning arresters	29.60
1000	Insulated tacks, double pointed	1.30
	Total	$796.04
	Average equipment cost per station	$11.72

This figure does not include the cost of installation, and as will be seen later, is a small part of the total cost of a group of farmers' lines. It must not be forgotten that with a common battery central energy system the cost per subscriber's station drops much lower, although in communities covering as much area as that at Melville the common battery system would be heavily taxed to give satisfactory service at such distances from the central office as are here shown. As the East Melville lead develops, it will probably be a wise move to locate a small central office somewhere near the center of the lead and give free trunking to the Melville office proper.

The inventory of line material is as follows:

1077	25 ft. cedar poles, 7 in. tops (at Melville), at $2	$2,154.00
4	35 ft. cedar poles (at Melville), at $5.65	22.60
256.8	Miles No. 14 iron wire, bare	986.00
754	10 pin crossarms, painted, at 41 cents	309.14
116	10 pin crossarms, unpainted, at 36 cents	41.76
18	2 pin crossarms, painted, at 11 cents	1.98
1155	Brackets	15.03
7463	Plain glass insulators	205.23
198	Transposition insulators	13.86
1740	Crossarm braces, 2 in. by 1¼ by ¼ in.	104.40
1185	Feet 5/16 in. guy wire	15.20
1140	Feet ⅜ in. guy wire	18.35
4386	Log screws (7 in., 3 in., 2½.)	72.05
9971	Nails (8, 20 and 30 d.)	5.30
68	Anchor blocks	10.20
1776	Washers, 1⅜ in.	40.00
6	Guy stubs, 20 ft.	9.00
64	Anchor rods (6 in. by ½ in.)	22.40
6	Anchor rods (6 in. by ⅞ in.)	2.70
7661	Insulator pins	86.18
68	Guy clamps	10.20
1820	Feet x 22/50 pair No. 22 aerial cable (22 wires to E. Melville)	147.00
1126	Feet x22/100 pair No. 22 aerial cable (22 wires to E. Melville)	68.00
1	Cable box and platform (22/50 for E. Melville), at $20	8.80
	Total	$4,369.38
	Per subscriber	$64.30

The cost of the central office equipment for the East Melville lead was figured at $123. Hence, the total cost of equipment was $5,288.42, or per station $77.60.

If this represented the installation cost complete there would be reason for great satisfaction on the part of the investors in the

property. Unfortunately, the extent of area covered by the East Melville lead brought the cost of erecting the poles and wires to $4,300. On the cross arm sections the poles are spaced 36 to the mile and on the bracket lines 18 to the mile. It is exactly this scattered area of subscribers which runs the cost of installation and maintenance up so high in extensive rural telephone systems. The labor cost of installing the 68 stations at $1.50 each was $102; the freight on the central office and subscribers' equipment came to $10, and the freight charges on the pole line equipment were $21. Thus, the total first cost of the lead complete and ready for operation was $9,721.42, or $143 per subscriber.

The operating expenses and fixed charges of the East Melville lead were as follows:

Interest, 6 per cent. on $9,721.42	$583.00
Depreciation	468.61
General expense	384.00
Taxes	50.70
Salaries of local operators	106.50
Salary of superintendent	51.26
Rent, heat and light	23.78
Wages of line and repair men	113.22
Material	70.56
Livery expenses	159.00
Miscellaneous	77.50
Total annual cost of operation	$2,088.13
Per subscriber's station	$30.80
The annual revenue was:	
61 Farmers' stations, at $30	$1,830.00
4 Farmers' stations, at $24	96.00
3 Business stations, at $48	144.00
Total	$2,070.00
Per subscriber's station	$30.40

It will be seen from these figures that the East Melville lead just about pays 6 per cent. interest on the investment. With the addition of new subscribers in the district there is no doubt that the cost of operation per station will decrease, since a much larger number of instruments can be cared for with little additional expense on the score of line troubles. The establishment of a common battery office near the center of the district is bound, when the volume of traffic justifies it, to reduce greatly the maintenance charges. An important result of the traffic study was that which showed the popularity of the telephone as a means of making social calls by proxy in the evening. From about 7 o'clock to 9 p.m. the lines were especially busy with conversations of this nature between parties several miles apart who were thus able to visit without the drawback of "hitching up" and driving a good many miles from farm to farm. This practice was, of course, not entirely free from the drawback of "busy" reports when other parties desired to converse. Records of the length of these telephonic "visits" varied all the way from two or three minutes to half or three-quarters of an hour, and in one case the conversation lasted an hour and fifty minutes, although the record did not state the sex of the participants. The traffic began to be active each morning about 4 o'clock and reached a maximum about 9 a.m.; it then sagged perceptibly until the latter part of the afternoon and early evening. The office was open 24 hours per day and 7 days per week, although the night calls were so few that the night operator was allowed to sleep on a sofa near the switchboard, a vibrating bell being connected with the drops so as to ring whenever a call came in.

The central office equipment in this study was composed of a two-panel, upright, 100-line magneto switchboard connected to 168 local lines and 18 trunk lines to adjoining towns. There were 24 operators' cord circuits, one 200-line distributing frame with suitable arresters and automatic protectors, two ringing machines and appropriate batteries. A 20-line toll desk switchboard handled the long-distance traffic during the daytime, and at night the toll circuits were plugged into the local board, to be handled by the single local operator on duty. The drops corresponding to East Melville circuits were marked with a black cross on the inside of the shutters, to enable the operators to distinguish them quickly without burdening their memories. Tally sheets were provided each day for the operators, and all originating calls were marked off by hundreds on a small peg board resembling a cribbage outfit. The average of a few tests taken at random with a stop watch showed that the answering plug of the operator was inserted within the jack within 2.9 seconds after the drop fell announcing the call; that the operators asked, "number?" in 3.9 seconds from the falling of the drop, and completed the desired connection in 7.9 seconds total time. This compares very favorably with the best service of manually-operated exchanges, and is an indication of the quality of service which the Melville community received throughout.

The total number of calls originating in the Melville exchange during the month was 89,767. The population served was approximately 3,000. Of these 7,613 calls, or 11.8 per cent., came from the East Melville lead. The average length of metallic circuit between adjacent subscribers was 1.9 miles. Each telephone averaged between 6 and 7 originating calls per day in the exchange as a whole. The average number of originating calls per station on the East Melville lead during the month was 112, or between 3 and 4 per day. The total number of toll calls originating in the Melville exchange was 994, or something above two calls per subscriber's station. The revenue from these calls was $277.10, or .62 per telephone. The total time occupied by toll conversations originating in the exchange was 3,304 minutes, or 3.3 minutes per conversation. The total number of toll calls originating on the East Melville lead was 57—less than one per station. The revenue from this business amounted to $15.45 during the month, or $0.227 per call. The total time of the toll conversations originating on this lead was 187 minutes, or 3.3 minutes per conversation.

The maintenance of the lead was taken care of by two linemen, who also covered the rest of the exchange. They worked in toto 28 hours on the lead during the month; their wages aggregated $9.44 for this service, and the livery charges were $13.25.

The average investment per station in the Melville exchange was $81.50 and the effect of the long lines in the farming region is easily seen by the 75 per cent. increase in the cost of the plant, which brings the East Melville figure to $143.

At the central office the business was handled by one chief operator at $35 per month, a second operator at $30, and four operators at $25 each. All operators but one worked eight hours per day, and this one—the night operator—was on duty 12 hours during the night. There was also a substitute operator, paid 10 cents per hour. The superintendent's quarters were at the central office, but a large part of his time was devoted to personal business which he carried on in addition to his telephone work. New contracts and bills were looked after by the superintendent.

No allowance was made in the operating expenses for insurance, bad bills, overdue collections or livery arising therefrom; and no reserve fund was provided to meet the contingencies of unusually heavy storms or other accidents.

It was realized that a single month's study was inadequate to determine absolutely the yearly cost of operation, but the investigation certainly showed the general run of expenses in the particular class of service involved. Possibly the reader will conclude that both rates and expenses were too high, in comparison with the $18 farm telephone rate in force in some parts of the country, but a glance at the distribution of subscribers will, in some measure, account for this, together with the fact that labor and materials are costly in the Melville district. It would seem that as a fixed rate $30 was not excessive for the service given. However, there is room for discussion of the zone system of rates, on the basis that the more distant farmers should pay more for the service which costs the company so much more also. The problem of rates is a question beyond the scope of this article, the writer's object being simply to present for consideration the exact and complete data of a concrete case of 1904 telephone practice in a farming community.

Madison Branch of the A. I. E. E.

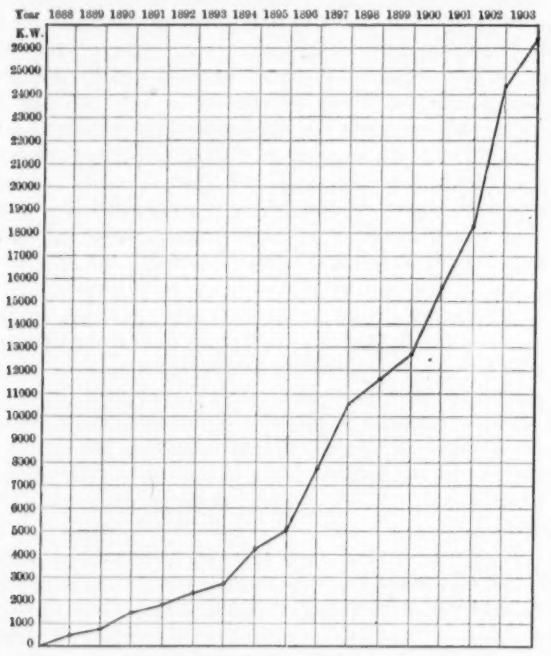
Two regular monthly meetings of this branch have been held, in addition to six student meetings, which student meetings are carried on as a part of the regular work of certain senior and graduate students in engineering at the University of Wisconsin. The first monthly meeting was held October 26. The election of officers for the year was held at this time and resulted in the selection of Mr. J. P. Mallett, chief engineer at the Northern Electric Manufacturing Company, as chairman; G. C. Shaad as secretary and F. W. Huels as a third member of the executive committee. The papers presented at the New York meeting in September were abstracted by Messrs. Potter and Jorstad. The second monthly meeting was held December 1. At this meeting the paper on the telautograph was abstracted by Mr. R. F. Robinson, and the paper on the transposition of electrical conductors was presented by Mr. R. C. Muir. Mr. J. C. Potter prepared an opening to the general discussion in each case. At the student meetings several papers, based mainly on previous papers presented in the Institute and covering a variety of subjects, have been presented and discussed. There are at present ten students electing this work, the number of students who are allowed to elect this course being limited.

Japanese Electrical Association.

The accompanying curve of the growth of central station electric lighting in Japan is from the photograph of a chart compiled by the Nippon Denki Kiokwai, the Japanese Electrical Association, which corresponds to the National Electric Light Association of this country. The association was founded in 1892 for the purpose of investigating and reporting on matters of importance to the electric light industry; to represent the industry before the government, to publish its proceedings, popularize electricity and maintain in Tokio a permanent electrical exposition.

The membership of the association is divided into three classes, namely, honorary members, individual members and companies and firms. A general meeting is held annually and intervening general meetings may be called by the president. The executive committee meets monthly. The fee for individual members is $2 per year. The fee for companies and firms is graded according to the paid-up capital of such members, and ranges from $200, corresponding to $1,000,000 capital or over, to $10, corresponding to $100,000 capital or less.

Only members of the association are allowed to exhibit their goods



CURVES SHOWING TOTAL CAPACITY OF JAPANESE CENTRAL ELECTRIC LIGHT STATIONS.

in the permanent exhibition building in Tokio. The building is open twelve hours each day, excluding Sundays and national holidays. All expense connected with the arrangement of exhibits for special electric lighting or for operating machinery is borne by exhibitors. A library is also maintained in the building for the benefit of members of the association. In case of applications for purchase, the authorities in charge of the building offer every facility toward bringing the purchaser in communication with the seller. The total area occupied by one exhibit is not allowed to exceed 3 cu. ft. and the total weight cannot be over one ton.

Interstate Independent Telephone Convention.

As already announced in these columns, the annual convention of the Interstate Independent Telephone Association of America will be held at the Auditorium, Chicago, December 13, 14 and 15. The official programme includes the following papers: "Why Independent Telephone Securities Do Not Command the Market Price They Deserve According to Their Earning Capacity," by O. M. Bake, Hamilton, Ohio; "What the Independent Telephone Companies Owe to the Public; What the Public Owes the Independent Telephone Companies," by Theo. Thorward, South Bend, Ind.; "Manufacturers' Duties and Their Dues," by E. D. Graham, Mexico, Mo.; "Uniformity of Equipment and Standardization of Apparatus the Imperative Demand in the Operating Field," by J. H. James, Mankato, Minn.; "The Importance of Bringing About, by Legislation or Otherwise, Uniform Telephone Rates for Exchange Service in Towns of the Same Size; also Uniform Toll Rates," by E. H. Moulton, Minneapolis, Minn.; "How to Avoid Personal Injury and Responsibility in Telephone Construction Work and Maintenance," by Senator R. C. Stephenson, Rochester, Ind.; "Where Are We? How Did We Get There? What of the Future?" by A. C. Davis, Parkersburg, W. Va.; "The Evils of Connecting With the Bell," by P. C. Holdoegel, Rockwell City, Iowa. On the night of December 15 a banquet will be held.

The Growth of a Great Lighting System.

The New York Edison Company gave a banquet to its agents and inspectors at the Hotel St. Denis on Tuesday, November 29. Besides the officers of the company, more than 80 members of the contract and inspection department were present. The affair was a decided success in every way. At the speakers' table sat Nicholas F. Brady, Thomas E. Murray, J. W. Lieb, Jr., A. A. Pope, C. A. Littlefield, R. U. Conger, of the Sheldon School of Scientific Salesmanship, and Arthur Williams, who presided In introducing Mr. Lieb, the first speaker of the evening, Mr. Williams said: "One's memory readily goes back to the time when all the employes of the company numbered less than half of those present this evening; when the entire territory supplied covered less than one square mile, instead of more than seventeen square miles, as at present; when there were less than 300 customers, instead of something more than 34,000; when there were no arc lamps, compared with about 23,000 supplied to-day, and to the time when the first horse-power in an electric motor applied to commercial service was connected as a class of our business, which has now grown to more than 90,000 hp in motors engaged in every industry in New York City, in which mechanical power is used. But the greatest part of this extraordinary development has occurred within the last five years, in which years the growth has more than equalled the aggregate growth of the preceding seventeen years of the company's history. Our customers have grown from 16,000 to the present number of nearly 34,000; the incandescent lamps from 750,000 to 1,600,000; arc lamps from 10,000 to 23,000, and power from something less than 40,000 to something in excess of 90,000 hp. With this growth it has been necessary to separate and divide our outside forces—referring to only one department of the company's work—into a number of camps or groups of thought and effort, and in this separation the possible tendency has perhaps been away from those conditions which may make most for absolute unity of purpose. Hence, largely, we are here 'getting together' this evening. We shall now have the pleasure of listening to the address of the gentleman who holds the highest office in the gift of American engineers—the presidency of the American Institute of Electrical Engineers—and who is, as well, vice-president of our company, Mr. J. W. Lieb, Jr."

Mr. Lieb, after some reference to the early history of the lighting industry in New York City, alluded to the change in policy of electric light companies, and gas companies, as to vigorous advertising for new business, and the development of novel lines of application for the use of electric current. He also pointed out that it was well that the business forces of the company—the agents, inspectors and others interested—should meet in the way that has become a recognized feature in the conduct of business, by the technical staffs of the different companies, in order to discuss and compare notes, as to the special department of work in which their activities are exercised. Reference was also made to the important work which those representing the company perform, who come in direct contact with the customer, in making known the new requirements which it may be necessary to meet from time to time, and lines of work which must appeal to the public. In speaking of the various activities on the part of the commercial branches of the company, Mr. Lieb mentioned the very successful work performed by the *Bulletin*, issued by the Advertising Department of the company, which has met with pronounced success, and had found many imitators among the other lighting corporations.

In introducing Mr. Conger, the toastmaster said: "One of the most noticeable features in connection with the World's Fair was the progress shown in educational methods in this country. Not only in the education of the child, but in the principles that have

been developed for the education of the adult, after entering the working period of his life—the period which has been heretofore largely considered as closed, from an educational standpoint. I refer in this to the correspondence schools, a single one of which, it is claimed, has the striking membership of 700,000, and a staff of not less than 3,200 instructors."

Mr. Conger spoke entertainingly of his theories on the science of the salesman. Salesmanship, he declared, was, indeed, a science, and should be dignified as such. The speaker pointed his remarks with amusing stories and personal anecdotes. He dwelt in detail upon the characteristics which, he asserted, were the prime requisites of scientific salesmanship. Tact, he said, was one of the chief of these. In defining this essential quality of tact, he said: "Tact is a product of judgment, intuition and brotherly kindness, and becomes part of a salesman's personality, when these traits have been so cultivated that they enable him to quickly appreciate the circumstances surrounding every situation so adroitly and skillfully that he meets each occasion with perfect poise."

Magnetic Storms and Sun Spots.

Advices from London state that the data given by E. W. Maunder, superintendent of the solar department of Greenwich Observatory, who announced last week before the Royal Astronomical Society as to the familiar magnetic disturbances which derange the mariner's compass and their relation to sun spots, has created the deepest interest in astronomical circles.

In connection with magnetic storms some kind of solar activity has never been denied. The real point of Mr. Maunder's discovery is the fact that these storms recur at regular fixed intervals. After marking out the times that hundreds of storms were found, some of which corresponded to big sun spots and others which did not, he tried vainly to find a correspondence with the faculæ or flecks of boiling fire on the sun's surface and with the prominences.

At last he noticed that there were frequently a series of magnetic storms at intervals of exactly 27⅓ days. Sometimes there was no storm at the end of this period, but the storm was repeated after exactly two or three such intervals. Now, 27⅓ days is the exact time for a point on the sun to go once around and appear opposite the earth again. The storm arrives generally 26 hours after the sun spot points directly toward the earth. It is presumed that that time is taken in rushing up particles to reach the earth, though the storm comes again and again after the sun spot has vanished. It is generally just at the time when the place where the sun spot was, in passing; that is, the sun spot has gone, but a stream of magnetic commotion is still proceeding at the same point.

Still more remarkable is the discovery that there are certain favorite points on the sun for sun spots and magnetic streams which continue after the sun spots have vanished. One center of such disturbances is a point on the twenty-second degree of the sun's longitude. It has been pointed out that it is strange that this repetition of storms at intervals of 27⅓ days has not been noticed before, as Hornstein long ago announced that he detected a minute regular swing of the magnetic needles having the same period.

Ramsay on Radium.

In *Harper's Magazine* for December Sir William Ramsay, the discoverer of helium, writes of "Radium and Its Products." The results of Ramsay's work have been almost a justification of the idea of alchemy—the transmutation of one metal into another:

"The chemical examination of the products of change of radium leads to a hypothesis as regards the constitution of radium and similar elements, which was first put forward by Rutherford and Soddy. It is that atoms of elements of high atomic weight, such as radium, uranium, thorium and the suspected elements—polonium and actinium—are unstable; that they undergo spontaneous change into other forms of matter, themselves radioactive, and themselves unstable; and that finally elements are produced which, on account of their non-radioactivity, are, as a rule, impossible to recognize, for their minute amount precludes the application of any ordinary test with success. The recognition of helium, however, which is comparatively easy of detection, lends great support to this hypothesis.

"The natural question which suggests itself is: Are other elements undergoing similar change? Can it be that their rate of change is so slow that it cannot be detected? Prof. J. J. Thomson has attempted to answer this question, and he has found that many ordinary elements are faintly radioactive; but the answer is still incomplete, for first, radium is so enormously radioactive that the merest trace of one of its salts in the salt of another element would produce such radioactivity; and, second, it is not proved that radioactivity is an invariable accompaniment of such change; or again, it may be evolved so slowly as to escape detection. A lump of coal, for example, is slowly being oxidized by the oxygen of the air, oxidation is attended by a rise of temperature, but the most delicate thermometer would detect no difference between the temperature of a lump of coal and that of the surrounding air, for the rate of oxidation is so slow."

President Siemens of the British Institution of Electrical Engineers on the Metric System.

Mr. Alexander Siemens, president of the British Institution of Electrical Engineers, in his recent presidential address strongly advocated the adoption of the metric system in Great Britain. Below we quote the part of his address devoted to this subject:

One feature of electrical measurements has contributed more than anything else to the rapid rise of the industry, and that is the adoption of the same units of measurement in all countries. The idea of such a system originated with Prof. Wilhelm Weber, of Göttingen, about 70 years ago, but the British Association for the Advancement of Science has the honor of having taken the first step to realize the proposal of Weber by appointing a committee to suggest practical electrical units. This committee, after due deliberation, chose as the basis of their system the centimeter, the gramme and the second, and I should like to know why they chose the metrical units, unless they had convinced themselves that these were the best for the purpose. At that time (1861) there was no question of international units, nor had the metrical system been adopted as universally as it is now; all the more weight ought, therefore, to be attached to the decision of this committee, which consisted of eminent scientific men and prominent engineers, so that both the theoretical and the practical aspects of the question were kept in view during their deliberations. Certainly there is no doubt about the beneficial effect of the adoption of this system by all countries, and I have no recollection of ever hearing that the decimal division adopted in it has given rise to any difficulties. It is true some modifications have become necessary, which were discussed and accepted at a series of international congresses called for the purpose, but so far as I am aware nobody has ever suggested that it would be to the advantage of any country to start a system of electrical units of its own. In spite of this favorable experience, we all know that there exists still an obstinate resistance against the general introduction of the metrical system into this country, although it has been shown over and over again that the reasons advanced for this obstruction are based on fallacies and are opposed to the experience of other countries. Such an attitude is very largely due to want of practice with a thoroughly consistent system of weights and measures. In this connection it is significant that all engineers who have had to deal for any length of time with metrical measurements unhesitatingly prefer them to the English want of system. I am, of course, aware that some prominent engineers profess to have tried to work with metrical units, and have been unable to work as quickly and easily with them as they could with their accustomed units. About them one is tempted to say that their conclusion in this particular matter is about as reliable as that of a man who tries to skate, and, after his first attempt, gives it as his opinion that you cannot move faster by skating than by walking. Another big outcry is raised against the metrical system on account of the disturbance of all business transactions that would result from the change of weights and measures, and appalling figures are marshalled as to the expense of giving effect to it. It does not appear that other countries have been ruined by discarding obsolete weights and measures, nor should the expert opinion of the inspectors of weights and measures be ignored, who unanimously consider the introduction of the metrical system to be a pressing need to put an end to the existing confusion, and advocate, in addition, that such an introduction should be made compulsory. The very same thing has been recom-

mended by two or three Parliamentary committees, after hearing innumerable witnesses for and against the change. Why should such well-considered opinions be calmly ignored, and why should the bogie of expense be trotted out before the public, when the real sentiments of the opponents about the disturbance of trade, caused by a change of weights and measures, are disclosed by the fact that they themselves advocate a revised British system, based on the inch, the introduction of which would have the same disturbing influence as that of the metrical system, but would lack the advantage of making the international metrical system the universal one? For it cannot be doubted that the example of Great Britain would immediately be followed by the British colonies and by the United States, so that the whole community in all civilized countries would enjoy the same advantages as the electrical engineers already possess.

Against this argument the opponents of the metrical system usually point out that even in France some instances can be found where the old measures are used in preference to the metrical ones, but on examination it turns out that only the old names are preserved in some districts and in some trades, but that in reality the measures in use are based upon metrical units. The few exceptions are only proving the rule; and it would be as wrong to say that the metrical system is not universally used in France or Germany, as it would be to contend that English is not the language of the United Kingdom, because you can find people in some remote parts who do not know that language. As a last resort the expense of changing the screw threads is urged against the change to the metrical system, and the continental practice of calling their system "Whitworth Thread" is considered an incontrovertible proof that the metrical screw thread is impracticable. If all taps and dies and leading screws had to be exchanged at once it would certainly be a costly affair, but such a measure is not likely to be adopted, as no advantage could result from it. For the real difficulty with screw threads is that giving dimensions on paper is not sufficient to insure that the screws, manufactured according to such instructions in different works, are really interchangeable. This subject has been investigated by a committee of the War Office, and their conclusions throw a very interesting light on the controversy. In their opinion it is only possible to obtain interchangeable screws, if the leading screws by which they are made have all been cut on the same screw-cutting lathe, or are at least cut on benches which are fitted with a leading screw manufactured on the original bench. If another link is interposed differences in the screw turned out become perceptible. As a consequence of the finding of this committee a screw-cutting lathe has been set up at the National Physical Laboratory, where leading screws for screw-cutting lathes are to be manufactured. The same experience has been made in other countries, where nominally "Whitworth Threads" are used. It is not possible to make screws interchangeable by prescribing their dimensions; the only way is to obtain taps and dies or leading spindles cut by the same tools. If it is not a case of extreme accuracy, there is no difficulty in cutting English thread by means of a metrical leading screw or vice versa. By using a wheel with 127 teeth on the driving axle an accuracy of 1:6350 can be obtained, which is sufficient for ordinary purposes. In any case it is much to be regretted that such a useless encumbrance of our daily life, and such an obstacle to foreign trade, as the English system of weights and measures, has not yet been abolished.

Coal, Coke, Gas and Electricity.

In making its annual canvass of the coal mining and coke making industries for the last two years, the United States Geological Survey has extended its inquiries to cover all plants producing gas and coke from coal with the recovery of the tar and ammonia. Reports were received in 1903 from 528 companies. The facts gleaned from these reports are set forth by Mr. Edward W. Parker in a paper entitled "The production of gas, coke, tar and ammonia at gas works and in retort coke ovens in 1903." This report is published as an extract from the Survey's forthcoming volume, "Mineral Resources of the United States, 1903." The total quantity of coal carbonized in 1903 was 5,843,538 short tons. The 528 companies produced 33,483,430,989 cubic feet of gas, of which 2,433,969,478 cubic feet were lost or unaccounted for and 31,049,461,511 cubic feet were sold. Of this total 73.9 per cent. was sold for illuminating purposes and 26.1 per cent. for fuel. The average price per 1,000 cubic feet for all gas sold in 1903 was 97 cents. Prices for artificial gas are low in those States which have coal and natural gas.

The total production of coke amounted to 3,941,282 short tons, of which 1,882,394 short tons were obtained from by-product coke ovens, and 2,058,888 short tons were the product of gas houses. Many coke companies are engaged also in the electric light business and coke produced at the gas works, as well as a considerable amount of tar, is used for firing in the electric light plants. Other coal gas producers are also producers of water gas, and the coke from the coal benches is used for firing the water gas plant. Some coke is also used in the carbonization of coal at some of the gas works. It will be noted, therefore, that not all of the coke produced at gas works in the United States is sold, a considerable quantity of it being consumed at the works where it is produced.

The total quantity of coal tar produced in 1903 was 62,964,393 gallons, valued at $2,199,969, or 3.49 cents a gallon. The largest production of tar in both 1902 and 1903 was in Massachusetts, with New York second, Ohio third, Pennsylvania fourth and Alabama fifth.

Only about 20 per cent of the companies that manufacture coke and gas reported the recovery of ammonia either in the form of ammoniacal liquor or sulphate. The total quantity of ammonia liquor produced and sold was 64,396,662 gallons, which would be equivalent to 17,479,759 pounds of anhydrous ammonia, or 67,821,465 pounds of sulphate. The total quantity of sulphate of ammonia produced and sold in 1903 was 11,925,752 pounds. The total production in 1903, equivalent in sulphate, was 79,747,217 pounds.

Comparatively little progress has been made in this country in the manufacture of chemical products from coal tar. Although we produce over 50,000,000 gallons of coal tar annually, we import at the same time millions of dollars' worth of chemicals obtained from coal tar. A conservative estimate would place the total value of these products in the wholesale markets of this country at $12,000,000. This is a reproach to American inventiveness and industrial economy.

Government Control of Power Development.

It is stated that the Canadian Government will discuss with the Washington authorities the advisability of appointing an International Commission to consider the effect upon the level of international waters along the boundary of power development works and other enterprises. There are said to be at least three instances where Canada has cause of complaint on this score by reason of works constructed in the United States. One of these is on the St. John River, the second is at the Soo and the third is in the State of Minnesota. With respect to the last-named matter a complaint shortly will be forwarded to Washington.

CURRENT NEWS AND NOTES.

YALE GRADUATES.—Of the 12,665 graduates of Yale now alive, 2,823 came from the scientific departments. About 96 per cent. of these graduates have been classified as to occupation, as follows: Engineering, 849; transportation, 191; manufacturing, 1,171. About 25 per cent. of those who graduated in theology and law have taken up other work.

NEW YORK SUBWAY.—The Interborough Railroad Company has opened its east side branch of the Subway, above Central Park, running up Lenox Avenue, the first station being One Hundred and Tenth Street. The line has immediately enjoyed a large patronage, as it taps a heavily populated district in Harlem, and is in fact more useful in that respect than the corresponding west side section to which it forms a spur. The new line enjoys express service also.

MILWAUKEE MUNICIPAL LIGHTING.—For a second time the faction favoring a municipal lighting plant for the city has lost in a vote before the City Council. Since the previous defeat of the measure in the council a few weeks ago, the question has been the occasion of several mass meetings and much heated discussion. One councilman, in order to obtain the opinion of his constituents, mailed to each of them a reply postal card. After the defeat of the measure for the issue of $150,000 bonds for the lighting plant, President John I. Beggs, of the Milwaukee Electric Railway & Light Company, offered to light the city at a rate equal to that which it is figured it costs the city of Detroit by its municipal plant. This communication was referred to the committee on street lights and judiciary.

STORM DAMAGE TO ELECTRIC WIRES.—The damage to telegraph wires in Maine by the recent storm was particularly heavy. It is estimated that 10,000 miles of wire were down in that one State. Much of the wire was so badly entangled that it was impossible to reuse it. It is calculated that the total damage to electrical wires in the State amounted to over $500,000.

CHECKING SWINDLES.—Fourth Assistant Postmaster-General Bristow in his annual report recommends to Congress that the Interstate Commerce law be amended so as to prohibit common carriers—to wit, telegraph and express companies—or any of their employes, from aiding and abetting in green goods or lottery swindles, or any other scheme carried on partly by mail and partly by common carrier, and which is in violation of the postal laws.

TROLLEY FOR GUATEMALA.—United States Consul-General Winslow, Guatemala City, says: "There is strong talk of installing electric motive power on the street car lines in this city. The current will be secured from one of the electric light plants that is run by water power, the power plant being about 30 miles from the city. There are now about 7 miles of single-track line, with a prospect of an increase in the near future. At present mules are used. Communications addressed to Ricardo Echeverria, general manager of the line, will receive due attention."

KILLED AT THE TELEPHONE.—A telegram from Brockton, Mass., of November 30 says: "Harry G. Marsters, manager for the Standard Oil in Southeastern Massachusetts, was killed by electricity in his office in Mulberry Street to-night. In hanging up the telephone while his left hand was on the electric lamp, the circuit was completed, and he was instantaneously killed. The electric lights in that portion of the city have been shut off and an investigation is to be made to ascertain whether the telephone company or the electric light company is at fault."

AMERICAN CHEMICAL SOCIETY AND THE METRIC SYSTEM.—At the regular meeting of the New York Section of the American Chemical Society, held at the Chemists' Club, November 11, the following resolution was adopted, after some discussion, without a dissenting vote: "The speedy introduction of the metric system of weights and measures by appropriate laws is most desirable in order to rid our country of a most illogical and cumbersome system, which is one of the greatest obstacles to the development of our export trade, and in order to place our country on a parity with other great manufacturing countries."

TELEPHONY IN NEBRASKA.—The following item from the *Benkleman News:* "The people of Eastern Nebraska have little idea of what they miss in the way of cheap telephone service by not living in the range country. Think of a monthly bill of 33⅓ cents for the use of a telephone. The latest barbwire line to go out of the village will be 12 miles long, and will include 15 telephones. The only cost to the subscriber will be that of the instrument that he uses and the trouble of making the connection, and the cost of maintenance is expected to amount to $4 a year. There is not an insulator on the fence, yet messages are carried perfectly the whole distance."

TELEPHONIC FOOLING.—Advices from Newcastle, Pa., say: "There will be a serious reckoning for some young woman, yet unknown, who for some days past has been having a lot of telephone fun with the society women of the town. Detectives have been put on the case, but nothing has been found. The plan of the young woman is to call some society woman to the telephone and tell her the line is being tested, ask her all sorts of foolish questions, make her talk into the receiver from impossible positions, and then with a gurgle say to her: "You have been very kind; now, won't you please stand on your head and see how well you can talk that way."

TELEPHONY IN ENGLAND.—At present the telephone is very little known in the rural districts in England. An experiment is just now being conducted by the postal-telegraph authorities. Its object is to ascertain how far it may be possible to make village post-offices serve the further purpose of public telephone call offices. Six villages have been selected, and in these anyone may now ring up a subscriber and communicate with him by telephone at the ordinary rates, which in this district amount to 12 cents for a three-minute conversation. If the person with whom communication is sought does not happen to be on the telephone list, the sender may telephone his message to the nearest post-office and have it delivered thence by express messenger. In the opposite direction—that is, from town to village—similar facilities will be available.

COMPENSATED SERIES MOTOR.—In order to be able to remove the magnetizing winding of an alternating-current, compensated series motor without disturbing the neutralizing coil, Mr. B. G. Lamme proposes to place the neutralizing conductors in slots cut in the place of the projecting poles of the stator. One-half of the neutralizing conductors in each pole piece are connected to the neutralizing conductors, which are located in the slots of the adjacent half of the adjacent pole piece, by means of end portions bent outward in a plane parallel to the end of the motor and then around the adjacent space between the pole pieces. This construction, for which a patent was granted November 22, 1904, permits of locating the magnetizing coils close to the pole tips, which tends to reduce the magnetic leakage around the coils and thereby to improve the operating characteristics of the machine.

ELEVATED FIRE CARS.—A report has reached New York from Chicago that the first fire cars to be used by an elevated road in this country have been installed on the Metropolitan elevated lines there. The cars correspond to ordinary fire department chemical engines, one car being stationed at each terminal of the four branches of the line. The cars were adopted in Chicago after a test in which a car traveled a mile and extinguished a fire within six minutes after the alarm was sounded. Each fire car is equipped with two 100-gallon tanks of chemical solution and two lines of hose, each 150 ft. long, with an additional 200-gallon tank reservoir. The crew of each car consists of two men. Superintendent Frank H. Hedley, of the Interborough Company, said that fire cars had never been thought of for the local elevated lines. "We have never had reason to complain of the efficiency of the New York Fire Department in the case of fires that threatened our property, and until we do we won't consider anything like elevated fire engines."

AUTOMATIC VOLTAGE REGULATOR.—The use of relay magnets for placing in and out of circuit certain auxiliary resistances in series with the field coil of a generator is embodied in a patent granted November 22, 1904, to Mr. W. L. Merrill. Connected directly in shunt to the main terminals, if the machine is a direct-current generator, or indirectly thus connected through the direct-current side of a miniature rotary converter, if the machine is an alternating-current generator, is a regulating magnet responsive in the strength of its magnetic core to variations of voltage between these terminals. Within the influence of the field of the controlling magnet is placed a stretched strip of magnetic material which opens or closes a contact so as to produce, through the action of the relay magnets, a corresponding variation in the resistance in circuit with the field winding. Condensers shunted across the contacts of each relay magnet serve to minimize the sparking due to the opening and closing of the circuits.

VARIABLE-SPEED INDUCTION MOTOR.—A patent issued November 22 to A. E. W. Meissner relates to a system of power transmission which the inventor terms an "electrical differential gearing" adapted for use in hoisting apparatus and in the steering gear of large vessels to be operated at a distance by electricity. For this purpose both the rotor and stator windings of an induction motor are supplied with polyphase currents, the magnetic field due to each of which travels in the same direction as the other. When the frequencies of the two polyphase currents are equal, the rotor will assume such a position that the opposite poles of the two rotating magnetic fields will face each other, and the rotor will remain at rest. When, however, the two frequencies are different, the rotor will travel in the positive or negative direction, according to the difference in the rate of travel of the magnetic field, the rotor being carried around at a speed such that the rotating field due to its winding will occupy at all times a constant position with reference to the revolving field due to the current in the stator winding. The variation in periodicity of each current can conveniently be obtained from inverted rotary converters by means of field resistance control.

DEAFNESS NOT A BOON.—A telegraphic dispatch from Bridgeport, Conn., says: "The Rev. Royal W. Raymond, pastor of the Stratford Methodist Episcopal Church, has hit upon a novel plan by which the deaf women in his congregation may hear his sermons. He has a horn like those used on graphophones set on his pulpit and connected by wire with the pews occupied by the women hard of hearing. Telephone receivers have been put in those pews, and when Mr. Raymond begins to talk the deaf members of the church put the receivers to their ears. The system was used for the first time last Sunday at the morning and evening services and it worked satisfactorily."

LETTERS TO THE EDITORS.

The Substitution of Electricity for Steam as a Motive Power.

To the Editors of Electrical World and Engineer:

SIRS:—In your issue of October 22 last you were kind enough to speak in a very complimentary manner of the paper recently presented by myself before the Engineering Congress at St. Louis.

The paper was hurriedly prepared at the eleventh hour, and probably more time was spent in "boiling down" than in writing it. From your comments it would seem that this process had been overdone, at the expense of making obscure my opinions on two or three important points.

In the discussion of the paper by Mr. Stillwell there are several points which seem worthy of comment.

(1) Mr. Stillwell stated: "A closer approximation might be arrived at by saying that all railways in which the traffic per day does not exceed 10,000 ton-miles per mile of double track belong to the class to which electrical equipment cannot be economically applied."

It seems to me that figures of this kind are more likely to lead to wrong conclusions than a general statement which does not attempt to establish any rule. For example, a road like the Manhattan Elevated could be profitably equipped electrically with a total traffic in ton-miles per day, but a fraction of what would be necessary on a line like the Pittsburg & Bessemer, where practically only heavy ore trains are hauled.

(2) As to costs of power stations, my estimate was conservative in the sense of being fairly high, but I think not unduly high for *average* conditions.

(3) The statement that "Maintenance of way remains practically constant in either case, although there may be some slight saving in favor of electric traction due to lighter trains and better distribution of weight," seems to me to be entirely accurate. Before the paper was "boiled down," there was a reference to the advantage of electric equipment in not having reciprocating parts as do locomotives. It was concluded, however, that the above statement covered the condition sufficiently, especially in view of the general experience that the portion of the weight of the motors which is carried directly on car axles without spring support results in a hammering of joints, which, in many cases, is more serious than that produced by locomotives where a greater proportion of the total weight is spring borne.

(4) As to fuel economy, Mr. Stillwell uses the figures of the Manhattan Elevated to prove that my figures are not sufficiently favorable to electric traction. Mr. Stillwell's point in this direction is sustained by the Manhattan figures, but this is not an *average* road; on the other hand, it is perhaps one of the most favorable examples to be found anywhere in the world.

(5) Mr. Stillwell's figures showing a very small consumption of electric power per ton-mile I assume must be for summer schedule, whereas my figures were intended to be only approximate and for average winter and summer conditions, including heating of cars.

(6) Mr. Stillwell says: "It is not accurate to say that *ordinarily* only 6 to 12 per cent. of the energy required to drive a train can be restored to the line." The writer's statement on this point was: "The energy which can be returned in this way (if 'cascade' control is used) is *ordinarily* restricted to from 6 to 12 per cent. of the *total* energy required." This was intended to mean 6 to 12 per cent. of the total energy required to operate the entire line, and, so far as data are available, is correct. Mr. Stillwell states that from tests made at Budapest, it was found that "more than 70 per cent. was restored to the line." This must apply only to the energy required to lift the train a given height, and obviously it would rarely if ever apply to a complete electric road. In the sentence following Mr. Stillwell says that the Ganz Company submitted a proposition in which it "guaranteed a restoration exceeding 20 per cent. by recuperation in braking." A return of 20 per cent. of total power required might be possible, but only unusual conditions would be likely to bring the total return of current above 12 per cent.

(7) In regard to relative merits of alternating and direct-current motors, Mr. Stillwell does not agree with the statement that "in nearly all cases where electric conversion is justifiable the use of direct-current motors will be advisable." I quite agree that there are many cases where the relative merits of the direct-current and alternating-current motors should be carefully considered, but until the single-phase motors have been developed in practical use to a somewhat greater extent than has yet been done, I believe that only in exceptional cases will direct-current motors be found less advantageous, all things considered.

In your editorial you also refer to my "prejudice" in favor of the direct-current system. This is largely due to the fact that the direct-current equipment throughout has been fully developed, and most of its weak spots have been eliminated.

If I "went out of my way to criticise" the three-phase railway systems, it was partly because I felt that they had received an undeserved amount of attention, and that much more is to be expected from the development and use of the single-phase system than from the use of the three-phase system. This was at least partially covered by a sentence on page 30 of the printed paper reading as follows:

"Unless unforeseen weaknesses develop in operation this motor (single-phase), including its control, has so many advantages as compared with the three-phase motor, that the latter seems to be clearly 'outclassed.' For a line operating an occasional service over routes running to considerable distances from the generating station, its use may be advisable and deserves careful consideration."

In my opinion these two sentences cover the situation accurately as of to-day. I have no doubt that the single-phase system will develop in a commercial way during the next two or three years, and then it would be justifiable to equip a larger percentage of the roads on which the use of alternating-current motors is now debatable than would be advisable to-day.

With reference to your editorial on the subject, I fully realize that it is possible to construct three-phase motors, which are neither "less efficient nor heavier for their output than direct-current motors." While this is possible, I do not believe it is *advisable* for *street railway motors*. To secure these results the three-phase motors must be built with extremely small air-gaps, and this necessarily means careful watching of motor bearings, and their frequent replacement or adjustment, and increased maintenance cost. It also means increased liability to interruptions of service on account of troubles with motor bearings; consequently, while agreeing with your statement as to the *possibility* of having three-phase motors, which are neither heavier nor less efficient than direct-current motors of equal output, I should certainly not consider it advisable for railway use.

In a recent examination of a proposed interurban road, of some 55 miles in length, the relative merits of the single-phase and direct-current systems were very carefully figured out. It was found that the complete single-phase equipment would weigh about 8 per cent. more than the direct-current equipment of the same capacity, which is a considerably better showing than a three-phase equipment would make in this respect. In the total cost of the road and its equipment only three items showed any considerable variation as between the two systems. For the alternating system the cars and equipments cost approximately 25 per cent. more; but on the other hand the sub-stations and the trolley and feeder systems, using 2,000 volts, on the trolley wires, cost only about one-third as much. The net result, however, is that for these three items the alternating system shows a saving of approximately 11 per cent. of the cost of the same items using direct current, but this saving is only about 2 per cent. of the total cost of the road and its equipment. In operating expenses the only considerable saving in favor of the single-phase system would be in the sub-stations, where no attendance would be required; but on the other hand, until the system has been commercially developed, there might be increased repair accounts, delays, etc., which would fully offset this. At most the saving in sub-stations would probably

not exceed 2 per cent. of the operating expenses, and the interest on the increased cost above about 1 per cent. additional.

Summarizing there is a maximum possible saving of about 3 per cent. in operating expenses, or 1½ per cent. of probable gross receipts. Against this there was the disadvantage of having an experimental system, and of having 2,000 volts on the trolley wire, with a possible danger to life of passengers should the 2,000 volts pressure at any time be carried to car steps or handles. Undoubtedly these can be insulated in a way which will practically or entirely eliminate any danger from this source, but the methods of securing such insulation have not yet been fully worked out. There are many minor points deserving study, but considering all of the advantages and disadvantages, it was finally concluded that "the inducements offered are hardly sufficient, considering the entire cost of the enterprise, to justify the installation of the alternating-current, single-phase system." This conclusion, of course, applies only to a single road and to the immediate future, and the writer most sincerely hopes to see within two years the single-phase apparatus sufficiently developed on a commercial scale, so that in a similar case the recommendation would be in favor of, instead of against, its installation. In any event, it is already sufficiently developed to warrant its careful consideration in many cases. Very respectfully,

LONDON, ENGLAND. J. G. WHITE.

Figures for Sparking Distances.

To the Editors of Electrical World and Engineer:

SIRS:—I note with interest your editorial on "Sparking Distances," in your issue of November 19, in which you point out the difference in the figures for sparking distance published by the American Institute of Electrical Engineers and those of Mr. Fisher in his St. Louis paper. In this connection may I call to your attention a paper on this subject published by W. Voege in the *Annalen der Physik,* Nov. 8, 1904? In this paper Foege describes experiments on the relation of sparking potential to sparking distance for a range of sparking distance from zero up to about 40 cm., and for potential differences up to 200,000 volts. The experiments were performed with alternating e.m.f's and for electrodes of all shapes. As the experiments were most carefully performed and as they seem to settle the question of discrepancy between the A. I. E. E. values and those of Mr. Fisher, I venture to bring them to your attention.

The results, briefly, are that, for sparking distance below 10 cm. the potential varies widely with the form of the electrode, but that above this sparking distance the curve is a straight line and independent of the form of the electrode. The value of the potential for a sparking distance of 10 cm. is found by Voege to be about 50 kilovolts and is thus in accord with the value given by the A. I. E. E. Voege's results are also in accord with those given by the A. I. E. E. throughout their whole range. The relation between sparking potential and sparking distance throughout the whole range of the latter is roughly expressed by a curve consisting of two straight lines. The break in the curve occurs in the neighborhood of 50 kilovolts maximum value; that is, about 35 kilovolts effective. For sparking distance from 10 to 40 cm. the relation may be expressed by the simple linear equation of

$$V = 4{,}800 \times d + 24{,}000,$$

where V is the *maximum* difference of potential and d is the distance in centimeters. This corresponds to a value of about 2.1 mm. per kilovolt. The experiments emphasize the unreliability of the values obtained for sparking distance under 10 cm.; above this value, however, the results seem to be exceedingly reliable. It would, therefore, seem more advisable in the measurement of potentials below 30 or 40 kilovolts—by means of a sparking distance—to employ a transformer for stepping up to a voltage somewhere between 100 and 200 kilovolts, if great accuracy is desired.

BALTIMORE, MD. JOHN B. WHITEHEAD.

The Air in the New York Subway.

To the Editors of Electrical World and Engineer:

SIRS:—Much has been said in regard to the ventilation of the New York Subway in the scientific and daily press. The idea of artificially ventilating the tunnel should, in my opinion, be abandoned on account of the serious annoyances that would result, especially in the noise produced by the fans and strong air currents, which would prevent the workmen along the track from hearing the approach of the train.

I do not believe, however, that even a simple artificial aeration of the Subway is necessary. The public has been excited over the peculiar odor and has come to the conclusion that it must be deleterious. It has also condemned the display of all placards and advertising matter on the ground that they are the abode of microbes, as if microbes were as fond of advertising as we, and as if the same bacteria would not find more comfortable lodgings in the seats, on the floor and on the straps!

Simply because the atmosphere of the Subway is not agreeable, the people have denounced it as detrimental. The public, however, should know that the existence of pernicious bacteria is not necessarily connected with unpleasant odors. We are all acquainted with the disinfectants in common use, which, on the contrary, are not pleasant to our nostrils.

As explained in the article which appeared in the ELECTRICAL WORLD AND ENGINEER (November 26), entitled "The air in electric subways," neither the kind of construction nor the level of the New York Subway should cause any alarm among the public. In fact, the constituents of the air circulating in the tunnel cannot differ sensibly in quantity from those of the outside air on account of the many points of communication with the outer atmosphere, the natural but often imperceptible draft and the throwing out, with consequent suction, of air through the openings, caused by the motion of the trains.

As to the air becoming vitiated by that expelled from the lungs, it is obvious that it can be no worse than in a closed, crowded car of the elevated or any other surface railway.

The odor observed in the Subway is due partly to the recent painting and to the concrete not yet sufficiently dried, as would occur in any new house or apartment. The peculiar odor observed by the traveling public in the Subway is due to a gas (new, allotropically speaking) which forms a new quantitative constituent of that ambient; this is the *ozone* which is generated by the imperfect sliding contact of the car electric equipment with the third rail. This, by itself, is indeed a deadly poisoning gas, but the quantity of ozone produced in the Subway should be welcomed by all who fear the possible action of deleterious microbes, since all the authorities on health agree on the strong, sure antiseptic properties of this precious element.

NEW YORK CITY. GIUSEPPE MUSSO.

"The Metric Fallacy."

To the Editors of Electrical World and Engineer:

SIRS:—Instead of continuing the discussion of the metric system on the lines laid down in the reviews of "The Metric Fallacy," published in your issue for November 5, it would be more appropriate at the present juncture to tell the story of the going down in defeat of the metric forces before the House Committee on Coinage, Weights and Measures last winter—the story of "the bright beginning and the bitter ending of a halcyon and vociferous proceeding." Such a story would not, however, be regarded as a satisfactory answer to your reviews.

REPLY TO DR. BELL.

So far as Dr. Bell's and Mr. Kapp's reviews relate to the use of old units in metric countries and to my table of non-metric units used in metric countries, they will be answered with the remarks of M. Guillaume upon these subjects. As for the rest of Dr. Bell's review, it contains not a word to disprove a line or syllable of "The Metric Fallacy." His attitude is that of one who *knows* the metric system to be perfect and that no difficulties stand in the way of its adoption. Even though the facts of "The Metric Fallacy" show, as they do, the difficulties to be so great that whole industries in France and Germany have never been able to adopt the system, they count, in his opinion, for nothing. His last paragraph is given up to an attack on Mr. Dale, and I can hope for nothing better than for your readers to compare Mr. Dale's unique disclosure of the hopeless tangle of the textile weights and measures of metric Europe with Dr. Bell's last paragraph, in which he has pointed out two

stenographer's errors which have crept into print, as such things occasionally do—I presume even in the columns of the ELECTRICAL WORLD AND ENGINEER—errors which are perfectly obvious as such, but which were duly pointed out as soon as discovered by an errata slip attached to the table of contents.

REPLY TO MR. KAPP.

Mr. Kapp's discussion is upon a plane much higher than the other contributions to the review. I note, however, that he, like all the others, fights very shy of Mr. Dale's disclosures and I am unable to understand how he obtained the impression that we "obviously wish to create the impression that [in Germany] the foot is used to the exclusion of the meter; that engineers' and architects' drawings are marked in feet and inches," as I am unable to find a sentence in the book that will bear that construction. The testimony of "The Metric Fallacy" regarding the large use of old inches in Germany relates to their shop use and comes from Mr. Henry Hess, who lived in Berlin for four years as the engineer of the German Niles Works, the erection of whose factory was under his eye. Considering the opportunities which he has had, his observations are certainly convincing, though they say nothing about engineer's or architect's drawings.

Mr. Kapp tells us that he knows "several English engineers who, although they figure their drawings in the English system, use the metric system in getting out the designs." Yes, and on page 119 of "The Metric Fallacy" he will find the cases of two engineers of the French Westinghouse Company who, though long resident in France and regularly accustomed to figure their drawings in the metric system, continue to make all their calculations in the English system, and on page 117 he may find the case of a naval architect who learned his profession in France and who declares "As far as calculations in the matter of ship building are concerned, it is just as convenient in every way, shape and form to use English measurements as French."

REPLY TO M. GUILLAUME.

My table of non-metric units used in metric countries was compiled from a much larger Government table covering all countries, metric and non-metric. Strict accuracy in the selections was a matter of great difficulty, involving, as it did, an accurate knowledge of colonial geography and of the extent to which the laws of mother countries extend over their colonies as well as much astuteness in recognizing metric equivalents, their multiples and sub-multiples. Under these circumstances I could not feel certain that among so many (nearly 500) units there might not be some errors, and *I placed at the foot of the first page of the table the following footnote* (page 60)*:*

"Examination of the table will show that strict accuracy in the selections is not easy. Owing to this difficulty I have endeavored to resolve all doubts in favor of the metric system, and following this policy, have omitted all Russian and Danish units. In spite of this policy it is possible that the table may contain a few units which should have been excluded, but for every such unit there are not less than three which belong in the table, but which, because of the above-named policy, have been excluded. The reader will note the numerous German units."

M. Guillaume, Dr. Bell and Mr. Kapp have ignored this footnote, which may accord with their idea of honorable discussion, though it does not with mine; and with a flourish of trumpets M. Guillaume points out several units among nearly 500 which should have been excluded from the table. "What are they among so many?" Divide the table in half if need be and it remains a thorn in the metric side. M. Guillaume objects to the presence in the table of Chinese units, and to those of Turkey and Egypt, which latter countries, he says, "have, as yet, adopted this system only as an approved standard." As a Frenchman he may be charitably excused for not knowing that Turkey, Egypt and the treaty ports of China are included in all our tables of the forty-three countries which are represented as metric, including the table which appears in the official report of the hearings of the House Committee on Coinage, Weights and Measures of the Fifty-seventh Congress, and the one published by the English Decimal Association, and the units of Turkey, Egypt and the treaty ports of China, therefore, belong in my table. Russia also is included in the Congressional list of metric countries and, by rights, all Russian units belong there also, but in an excess of generosity they were omitted.

M. Guillaume asserts: "I can affirm without fear of contradiction that no one in the countries or cities he mentions knows at the present time the units which he quotes."

This is the limit! In "The Metric Fallacy" it is shown of the forty-three countries which have been regularly claimed as wholly and exclusively metric, that in some the metric laws are simply permissive, exactly as they are here, the system being used practically not at all; in others the system, while in use for many years for government purposes, is used but little or not at all in trade and commerce, and that in none (France included) is it universal. Your readers will be interested to know that in the monthly *Bulletin* of the International Bureau of the American Republics the United States is regularly placed in the list of countries which have adopted the metric system! And we belong there quite as much as do some of the countries which as regularly appear in our own tables.

Of my portion of this book fifty-two octavo pages are given to evidence regarding the use of non-metric units in metric countries, of which pages the table consumes nine. Mr. Dale's eighty-seven pages refer chiefly to similar evidence of the use of old units, the facts disclosed by him being, in brief, that many of the textile industries of metric Europe *do not use the metric system at all as a mill system,* while in no textile industry of metric Europe is the system in anything like complete use. Why does M. Guillaume devote so much attention to pointing out an insignificant number of errors in my table, whose probable existence was admitted in advance, and substantially ignore all the rest of this overwhelming evidence? Why does he endeavor to override established facts by the weight of personal authority? It is the metric way.

And then M. Guillaume brings out that venerable friend, the calculation of the volume, weight and value of a square tank of liquid which, like the poor, we have always with us.

M. Guillaume tells us "Not the smallest place is offered in the new Japanese legislation for the British system." Perhaps not, but I find an ample place for it in the Japanese tariff schedule and the tariff schedule shows the practice of a government with respect to weights and measures if anything does. In the Japanese tariff schedule the liter appears fourteen times, the meter and the kilogram *not once,* but the square yard appears fifty-three times.

Go into the cotton mills of England and from there to Germany—skipping France—and to Austria, Russia, India, China, Japan and our own country, and everywhere except in France you will find the mill units of that industry to be the yard, the pound and the inch, *and they are such in many countries in spite of adverse legislation.*

REPLY TO MR. MILLER.

I am glad that Mr. Miller finds "The Metric Fallacy" a book which he "is at liberty to criticise without mincing words," as it releases me from any obligation to the contrary when discussing his review. He says "the author simply cannot conceive that those who differ from him on this question—even those who disavow belief in measures of compulsion—can possibly be frank and at the same time intelligent." Mr. Miller has, apparently, forgotten that "actions speak louder than words," and I must own my doubts as to the frankness of those who disavow belief in measures of compulsion in one breath and advocate a compulsory measure in the next. If he will turn to Dr. Bell's contribution to this review he will find the following expression (italics mine):

"Under the proposed law it is a matter of profound indifference to the general public whether Mr. Halsey and his crew of kickers use the metric system or not. They can measure length in Chinese chiks and weights in Javanese catties if they like, but in dealing with Uncle Sam *they will have to* adapt their heathen units to the simple system employed by most other civilized governments."

Obviously, Dr. Bell is not a master of that refined logic which can prove that black is white.

One of the active metric party in Washington is Dr. W. H. Seaman, who, among other contributions to pro-metric literature, has published one of the many replies to my A. S. M. E. paper of 1902, in which he owns up frankly (italics mine): "Finally, no doubt the legislation in favor of the metric system would make it compulsory on those doing business with the government. *If it did not it would not be of any value.*"

Most of your readers will, I think, agree with Dr. Seaman, Dr. Bell and myself that the bill is compulsory on those who do business with the government, which is all that I have claimed.

Mr. Miller refers to my "weak attempt to show that Mr. Attorney-General Knox's interpretation is erroneous." The Attorney-Gen-

eral's opinion, which may be found in the *American Machinist* for March 20, 1902, says in small part:

"The purpose and effect of each of these bills [two bills appear to have been submitted to the Attorney-General] is to establish the metric system as the legal standard of weights and measures in the United States, and to require all government departments to use only that system except in completing the survey of the public lands. This comes far short of attempting to compel the people to use only that system or prohibiting to them the use of any other or making invalid contracts expressed in other terms."

On page 129 of "The Metric Fallacy" the following may be found, there as here, in italics:

"The objectionable feature of this bill is that it is a compulsory measure as regards all who do business with the Government, and that it can do nothing but create endless confusion in our weights and measures."

Again, on page 131 is the following:

"The requirement that the system be used in Government work can do nothing more than force the adoption of a special system for that work; in other words, and in the name of simplification, compel the use of two systems where we now have one."

In these quotations I have recognized as clearly as is possible the Attorney-General's plain dictum that the bill makes the system compulsory in Government business, but not in the business of the general public. Mr. Miller, on the other hand, tells us that "a reasonable interpretation of the contemplated law is that a machine purchased for the Government shall be capable of doing work to the metric system, and that is all." The Attorney-General's opinion contains no warrant for this "reasonable interpretation," *and it is not I but Mr. Miller who sets his opinion against that of Attorney-General Knox.* Moreover, it is not a reasonable interpretation, but a nonsensical one. The bill relates to the goods purchased by the Government, not to the things made on them in case they happen to be machine tools.

Like a sensible man, I have accepted the Attorney-General's opinion, from the day I first saw it, but Mr. Miller has persuaded himself that because the Attorney-General has decided that the bill does not make the system compulsory in general business transactions, therefore it does not make it compulsory in business with the Government. *And he believes it* just as he believes that the National Tube Works make metric pipe in spite of the chief engineer's statement to the contrary, and just as he believes that standards based on the inch can, in practice, be measured in millimeters.

Mr. Miller objects to my use of the term "wallows," as describing the European situation. On page 25 of "The Metric Fallacy" is a fac-simile reproduction of the method of calculating the cost of a piece of worsted cloth as set forth in a recent German book. This method, which is but a sample that can be duplicated again and again, is thus described by Mr. Dale:

"The raw material is purchased by the *English pound.* The finished goods are sold by the *French meter.* The yarn counts are *English,* while the length and width of the finished goods are *metric.* The length of the yarn is expressed in *meters,* while the counts are *English,* based upon the *yard* and the *pound.* From this hodge-podge the weight of the yarn is calculated in grams, which is extended by another arithmetical somersault at a price given in marks per *English pound,* and to cap the climax the total length of the yarn in *meters* is reduced to *English yards* and then to *English skeins* of 560 yards each!"

On page 186 is a German yarn table which is thus described:

"The Austrian weaver runs his eye down the columns headed *English yarn number* until he reaches the line at the left of which is the set in threads per *Vienna inch* and there he finds the weight in *English pounds* of the yarn he needs for 100 *meters* of cloth 100 *centimeters* wide."

I think these illustrations, which may be repeated without limit, may be fairly described as wallowing in confusion. I suppose Mr. Miller would describe them as cases in which German textile men "have the good judgment to make more or less use of a standard which is of value to them."

Your readers will also please compare the above evidences of the use of old units in metric countries with M. Guillaume's assertion: "No one in the countries or cities he mentions knows at the present time the units which he quotes," and they will also please take note that "The Metric Fallacy" is filled with such evidence in an amount which cannot be repeated here.

The sheet anchor of Mr. Miller's faith in the feasibility of the adoption of the metric system is the plan of preserving existing standardized things by making no change in them, keeping the sizes as they are and measuring them in millimeters instead of inches. Mr. Miller, of course, understands the value of standards as well as any one can, but he considers this a perfectly easy, feasible and obvious way of preserving all that we have, while I regard it as a hopelessly impracticable and visionary plan, which is unworthy of a man of his intelligence. Many of your readers will, I believe, recognize the impracticability of the plan at once. Mr. Charles L. Stone, who has a letter in your issue for November 19, will certainly recognize it as he says:

"The most serious error into which the anti-metric advocates have fallen is the tacit or expressed assumption that because meters and feet are connected by a rather complicated numerical relation, common lengths after the adoption of the metric system would have to be expressed in long rows of decimals."

Mr. Stone will, however, note that it is precisely this use of fractional equivalents which Mr. Miller advocates as a permanent thing in connection with standardized things, and that it is precisely this which I have insisted would be intolerable (page 92 of "The Metric Fallacy"). Mr. Stone should fight it out with Mr. Miller, not with me.

Your pro-metric readers should understand what it is that Mr. Miller offers to them—the permanent use of fractional equivalents which, among other things, can no more be memorized than can a table of logarithms. Sensible shopmen will not contemplate, as Mr. Miller will not contemplate, abandoning our standards and those of them who favor the system are driven, as he is driven, to this expedient. The whole shop case for the system rests on the practicability of this expedient, a situation which is thus recognized in "The Metric Fallacy" (page 89):

"The irreducible minimum of the metric case is this plan of measuring existing sizes in millimeters, the feasibility of which becomes, therefore, the dividing line of all intelligent opinion upon this subject."

So far as the machine shop side of the case is concerned, all other phases of the subject might as well be dismissed until this is settled.

The reader who is disposed to agree with Mr. Miller may easily test the practicability of the plan by taking a scale of millimeters and with it laying off a few dimensions, such as 5/8, 7/8, 1¼, 1¾ or 3½ inches. *Kind reader, please do this, as it is what, under Mr. Miller's plan every draftsman and every man who measures from graduated scales will do,* for this is what is involved in laying down in millimeters standards based on the inch. *Try it.*

Mr. Miller has referred to our screw-thread and pipe standards as two that would be preserved in this way—keeping them as they are and measuring them in millimeters. Unfortunately for him, this is just what the Germans do not do—they have kept the English standards, but they continue to measure them in inches and they have done this for the same reason that has led the reader to fail if he has made the above recommended experiment. Just as the Germans continue to measure such English standards as they have preserved in inches, so we shall continue to measure such standards as we preserve in the same way. The practice of Willans and Robinson does nothing but confirm this conclusion. The chief difference between the Germans and ourselves is that we have a thousand such standards where they had one when they adopted the metric system.

Mr. Miller tells us: "At page 42 [of "The Metric Fallacy"] we are favored with a German table of sizes of English pipes the nominal sizes of which are given in fractions of an inch and their actual sizes in millimeters.". Mr. Miller must have read this table with his eyes shut. The dimensions in everyday use—the inside diameter and the pitch of the thread—are given in inches and *in no other way,* while the dimensions used only by the tool and gaugemaker—the outside diameter and that of the root of the thread are given in millimeters. Mr. Miller's facility in reading into my words meanings that are not there is magnificent, but it is not argument.

Mr. Miller tells us that "No standard that is of any value to us need be thrown away because we adopt the metric system." In the argument which he made before the Coinage, Weights and Measures Committee, Mr. William Sellers said:

"In the mechanical arts enormous loss would result from the sacrifice of all existing apparatus for measurement and the apparatus for cutting metal to different sizes and enormous cost to replace these with other apparatus to accord with the new system. * * *

Look through any well-equipped tool room, note the great variety of drills, boring bars and cutters, taps, dies, reamers and gauges that are made to standard sizes. All these must be first changed."

William Sellers & Co. have been making injectors by the metric system for over forty years, their injector department having been organized on the metric basis at its inception. So far as known, Mr. Miller has had no experience with the system whatever.

Mr. Miller has told your readers how Mr. Henning acknowledged before the A. S. M. E. his belief that standards would be changed. Dr. Stratton said before the Coinage, Weights and Measures Committee: "A change to the metric system of weights and measures would undoubtedly bring about in time a change in our system of screw threads." Are Mr. Henning and Dr. Stratton "fanatics" because, like me, they recognize the natural effect of making this change? Mr. Miller should get the shining lights of his own party to agree with him before calling me a fanatic for agreeing, on this point, with them.

Mr. Miller's plan for measuring existing sizes in millimeters is fully discussed in "The Metric Fallacy," my longest chapter being devoted to it, and I cannot be expected to repeat the discussion at length here. The price of the book is not enough to deter any one who has enough interest in the subject to desire to follow the matter up.

By a twist of logic, the ingenuity of which I cannot but admire, Mr. Miller endeavors to show that the letter of the mechanical engineer of the National Tube Works Company, Mr. Patterson (not Mr. Taylor, as Mr. Miller has carelessly read it) "sustains Dr. Stratton's statement" regarding the making of metric pipe by the National Tube Works Company. Dr. Stratton's statement reads:

"The National Tube Works has one of its largest mills fitted up for the system."

A more recent unpublished letter from Mr. Patterson reads in part:

"You can state that this company does not have one of its largest mills fitted up to use the metric system."

The letter from Mr. Patterson, published in "The Metric Fallacy," makes it plain enough that the only metric product made by the company is seamless tubing. The second letter, quoted in part above, says also:

"The quantity of seamless tubes made to exact metric measurements is so insignificant that it is not worth while going through the order books to determine the percentage of our total output that they constitute."

To Americans at the present moment the most important showing of "The Metric Fallacy" is that the scheme of adopting the system for Government purposes has been tried repeatedly and that it has uniformly failed to bring about the adoption of the system in trade and commerce, a showing that is certainly important enough to overshadow all minor questions. Why should Mr. Miller again bring forth his "reasonable interpretation" of the bill and ignore the fact that similar laws elsewhere have uniformly failed to do anything but create a special system used in business with the Government, but in no other? It is the metric way.

The ELECTRICAL WORLD AND ENGINEER has in the past professed to base its attachment for the metric system on the necessity of adopting it for the benefit of export trade. Why, then, does it and all of its reviewers ignore my chapter—the Export Trade Argument—in which the need of the adoption of the system for the benefit of export trade is shown to be of the same order as the need of a fifth wheel to a wagon? It is the metric way.

THE STRENGTH OF THE ANTI-METRIC CASE.

And now a word about the work accomplished by this book which you and your contributors so cordially despise, albeit your expressions of contempt are scarcely in keeping with an eleven-page review, nor do they look well alongside the fact that the book HAS WON THIS FIGHT.

When my paper appeared among those to be read at the December, 1902, meeting of the A. S. M. E., my voice seemed almost like that of one crying in the wilderness. The current was all in your direction and you had secured a favorable report of the bill to the Fifty-seventh Congress, the report being signed by every one of the seventeen members of the Coinage, Weights and Measures Committee except two. For a statement of the then condition, I can do no better than refer you to the opening paragraph of my paper which has been gleefully quoted again and again by metric organs as my confession of the strength of the metric case.

To-day we see almost nothing of the agitation in the public prints except an occasional belated review of "The Metric Fallacy," while, before the Coinage, Weights and Measures Committee of the Fifty-eighth Congress, the metric party was beaten worse than was the Democracy at the late election.

What has accomplished this great change? *This book and its forerunner, my paper of 1902, before the A. S. M. E.,* which so aroused the opposition as to overwhelm the metric party.

When the metric journals of the country combined have done something comparable with this, it will be quite soon enough for the metric advocates to profess contempt for the weapon that has laid them low. Meanwhile you should take a lesson from Goliath, whose contempt for David's sling suffered a rude check when the stone was slung.

You seem not to know that the American Society of Mechanical Engineers has voted against this bill by a majority of 3.6 to 1, and that among those members who are professors and teachers the reverse vote was 1.8 to 1. You seem not to know that the National Association of Manufacturers has condemned the bill by a vote of 3.3 to 1, the vote among the makers of electrical machinery standing 1.5 to 1. You seem not to know that in reply to the question, "Can you recognize any appreciable advantage to accrue from the adoption of the system as a basis of factory work?" the adverse vote *among those who had had experience with the system* was 2.4 to 1, this vote rising among those in the metal trades who had had experience with this system to 4.1 to 1. You seem not to know that the Manufacturers' Association called upon all important manufacturers' and other associations in the country to poll their members and that many of them responded, the result being that of twenty-three manufacturers' and builders' associations twenty-one opposed the bill. You seem not to know that the list of national organizations now registered in opposition to the bill comprises the American Society of Mechanical Engineers, the National Association of Manufacturers, the American Iron and Steel Association, the National Association of Carriage Builders, the National Association of Heating Engineers and Contractors, the Engine Builders' Association of the United States, the National Association of Builders, the National Brick Manufacturers' Association, the National Association of Machine Tool Builders, the Furniture Association of America, the National Metal Trades Association, the Association of Railway Master Mechanics, the Master Car Builders' Association, the Society of Naval Architects and Marine Engineers and the American Society of Heating and Ventilating Engineers. You seme not to know that the Chief Constructor and the Chief Engineer of the United States Navy, together with the predecessors of both, are opposed to this bill.*

Crossing the water you seem not to know that in England a British Weights and Measures Association has been formed to fight metric legislation with such names as these on the list of its executive committee: Archibald Denny, builder of the *Shamrocks;* Robert K. Gray, president of the British Institution of Electrical Engineers; Walter M. Musgrave, of the world-famous engine-building firm of John Musgrave & Sons; James Paxman, of Davey, Paxman & Co., and Thomas Walker, the electrical engineer in charge of the electrification of the London underground railways.

You seem not to know that several members of the British Engineering Standards Committee belong to this association; that, although appealed to do the opposite, the committee which has behind it the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects and the Iron and Steel Institute, has decided to make its standards English and not metric; that the secretary of the committee, after making, for the enlightenment of his committee, diligent and extended personal inquiry in this country during the autumn just past regarding the extent of metric sentiment here, went home satisfied that there is none worth mentioning. You seem not to know that your English contemporary, the *Electrical Engineer,* has enrolled itself among the opposition.

There are other things that you seem not to know, but the list is long enough, and within it you will find some of my "anti-metric

*We have noticed in our pages every prominent action above referred to, and on several occasions our references in this connection were made the subject of letters from Mr. Halsey or one of his kindred spirits, printed in our correspondence columns.

freaks," my "crew of kickers" (Dr. Bell). Within it you will find those who, with me, are "fanatics" and "blind partisans" (Mr. Miller)—those who, with me, are afflicted with the "Halsey hallucination."†

I congratulate you, Messrs. Editors and Reviewers, on your knowledge of the character and strength of the opposition and on your nerve in reproving me for using intemperate language, but I still await a serious attempt to answer "The Metric Fallacy."

I have not attempted in the above to answer all the points made by your reviewers and such points as are not answered I expect them, of course, to gleefully decide that I cannot answer. However, I have not aimed to satisfy them, for that is impossible, but to show those of your readers who are willing to be shown that the opposition to this system is not confined to "fanatics," "freaks" and "kickers," but that it numbers among its members many of the ablest minds in this country and Great Britain; that this book and its cause cannot be dismissed with a sneer, nor with a 20,000-word review, but that behind them is a mountain of facts that cannot be ignored and that no idea of the strength of the book can be obtained by reading attempts to belittle it nor in any other way except by reading it. If I have accomplished this it is all that can be hoped and more than can be expected when addressing a metric audience.

NEW YORK, N. Y. F. A. HALSEY.

[We hope that Mr. Halsey's ill-concealed opinion of himself as the Napoleonic factor in the anti-metric cause will not lessen the attachment to his person of that cause. Otherwise we would regret having broken a rule of journalism in giving place to a letter attacking reviewers. As an antagonist typifying the weakness of his cause, we cannot spare Mr. Halsey.—EDS.]

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Commutation and Stray Field.—NIETHAMMER.—A discussion of the conditions of commutation of direct-current machines and of the calculation of the stray field of induction motors. He says that his points of view have proven useful when tested on many hundred machines of all sizes. In the short-circuited coils of direct-current machines there are in the most general case two e.m.f's: first, the reactance voltage, and second an e.m.f. induced by the main field or by commutation poles. Condition for sparkless commutation is that the algebraic sum of these two e.m.f's differs as little as possible from zero. He discusses four cases of differing in the position of the brushes. For calculating the magnetization current of induction motors, the ampere windings are determined which are required per pole, to pass the revolving field through the air-gap and the iron. These ampere windings are calculated by most authors from the maximum values of the induction (i. e., 1.57 times flux divided by cross-section, on the supposition of sine waves). But the author states that he has found, especially with very high saturation of the teeth, that it is more correct to calculate with the mean value of induction; that is, the ratio of the flux to the cross-section. Although in practice the calculation of the reactance voltage by a certain formula has found general introduction for direct-current machines, this is not the case for determining the stray field of induction motors, although the determination of the latter is identical in principle with that of the reactance voltage. As reason is given that simple formulæ are required for the practice. Formulæ of these kinds have been given by Behrend and Behn-Eschenburg. The author gives a new theoretical formula, which, however, appears to be quite more complicated. He finally remarks that at present much time is spent in drawing very exact circular diagrams in which all different influences are taken into account; at the same time an approximate or estimated value of the stray coefficient is made use of. He believes it is much better to calculate the stray field by scientifically developed and empirically established formulas as exactly as possible and then to use the most simple form of the circular diagram. It is easy to take into account approximately the ohmic drop.—*Zeit. f. Elek.* (Vienna), November 20.

Speed Variation of Shunt Motors.—LEBLOND.—With shunt-wound, direct-current motors it is usual to insert a rheostat in the exciting circuit and to produce speed variation by means of changing the resistance. In general a diminution of the exciting current produces an increase of speed. But this is only true within certain limits. The author investigates the general problem how the speed depends on the exciting current, if the e.m..f at the terminals of the armature circuit and of the exciting circuit remains constant. He shows that when an electric motor operates in equilibrium, and when the field flux is continually diminished, the new speeds of equilibrium which are successively obtained become greater and greater as long as the counter e.m.f. remains greater than one-half the difference of potential; afterward if one continues to diminish the field flux, the speed of equilibrium decreases again.—*L'Industrie Elec.*, November 10.

POWER.

Dry Dock Pumping Machinery.—SHULTZ.—A fully illustrated paper on the development of dry dock pumping machinery, with notes on the new pumping plant of the New York Navy Yard, which serves to drain two parallel dry docks 350 and 625 ft. long. Three 42-in. horizontal-shaft centrifugal pumps of 50,000 gallons each per minute, interconnected to each dock through motor-controlled valves, are the primary units of the plant, while two 16-in. pumps of the same type serve to dispose of any leakage while the docks are empty. The priming of these pumps is accomplished by means of a 1-hp motor driving a 12-in. by 12-in. air pump connected to the tops of the volutes. The motive power is furnished by three 415-hp induction motors direct-coupled to the shafts of the large pumps, and each of the smaller pumps is driven by a 125-hp motor of the same class. These motors operate on a 60-cycle, 2,000-volt, three-phase, alternating-current circuit. While speed variation is desirable in connection with pumping, the conditions peculiar to the working of dry docks are different, since it is here most important to remove the water with the least possible delay. The pumps and motors were, therefore, designed for a rated speed corresponding to a head of 17 ft., within which head is included three-fourths of the entire amount of water in the docks. The pumps are started and maintained at this velocity, thereby obtaining a greater discharge during the first part of the pumping down to 17 ft. (which is the major part) and the efficiency lost in the increased discharge is far less than that lost in attempting to control the speed—and in addition there is the actual money value of the ultimate saving of time resulting. The current for these motors is supplied by means of a turbo-alternating unit of the three-phase, 60-cycle type, designed to run at 1,800 r.p.m. and at a primary voltage of 2,300 volts.—*Eng'ing Mag.*, December.

Power Distribution System.—An illustrated article on the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board's scheme. The area covered lies in the immediate neighborhood of Manchester. This scheme comprises a main high-tension generating station, supplying energy at a pressure of 6,000 volts to four sub-stations located in the respective joint districts; from the sub-station low-tension distribution for light and power is effected on the three-wire system, and the tramway scheme comprising some 20 miles of route is supplied with energy. The power house contains three 500-kw, three-phase alternators, the voltage being 6,000 and

†The official announcement of the recent formation of an English anti-metric society has just come to hand, and taking for granted Mr. Halsey's permission, we make his notice do double duty as also our announcement. As to the British Engineering Standards Committee, it has "behind it" the bodies named, not to repel the metric system, but to secure uniformity in engineering work admitting of standardization. So far as relates to electrical engineering, it follows the lead of the American Institute of Electrical Engineers—which is far from an anti-metric body—in the great work of its Standardization Committee. As to the apostasy of our esteemed English contemporary, its several older and its younger confreres have not followed it in a repudiation of a system which lies at the basis of electrical science.

the frequency 40. The alternators are excited from two 50-kw, direct-current dynamos. All sub-stations are equipped with motor-generators and storage batteries.—Lond. *Elec. Rev.*, November 11.

REFERENCES.

Zambesi Falls.—Miron.—A discussion of the proposed utilization of the power of the falls of the Zambesi River, in South Africa. The energy available would be "25,000,000 poncelets" (i. e., 2,500,000,000 kg. meters per second, or about 33,000,000 hp); that is five times the power of Niagara Falls. He discusses briefly how the electric power could be used in towns and mines in the neighborhood. He does not think that the plant would become a center of electrochemical industries, since the falls are at a distance of 2,560 km. from Cape Town, and the railroad freights are high.—*L'Industrie Elec.*, October 10.

Gas Engines.—An article by Strack, giving results obtained by him in practice with large gas engines is published in *Stahl und Eisen*, November 15; a paper by *Witz* on the design of double-acting gas engines in *L'Eclairage Elec.*, October 22.

Gas Turbines.—Barbezat.—A mathematical paper on efficiencies which may be obtained with gas turbines.—*L'Eclairage Elec.*, November 19.

Traction.

Calculation of Traction Networks.—Kerbaker.—A paper in which the author first discusses with the aid of diagrams the ordinary methods of calculating a traction network. In the case of a complicated network with many branches and several stations, the calculation becomes very cumbersome. The author suggests to prepare a model of the line as indicated in principle in Fig. 1 in which the

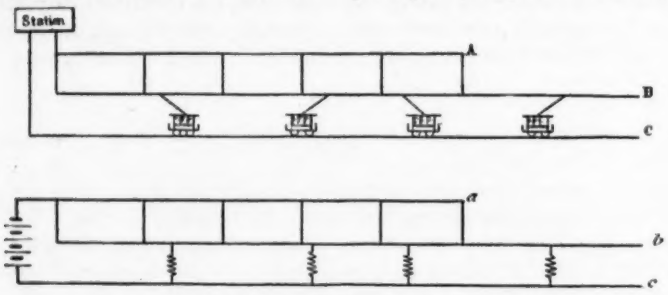


FIG. 1.—CALCULATION OF TRACTION NETWORKS.

upper diagram represents the network and the lower diagram the model. He says that this method has formerly been used for calculating the lighting network of Berlin and Milan. The station is represented in the diagram by one or more storage cells, the conductors *A, B, C* are replaced by three metallic wires, *a, b, c*, of resistances proportional to *A, B, C*. The trolley cars are represented by suitable resistances. By means of a milli-voltmeter it is then easy to determine the voltage drop along the line. The great advantage of the method is the ease with which the conditions of traffic can be changed in the model after it has once been prepared. It is then only necessary to repeat the voltmeter measurements to find how the conditions have changed. Some details are given on the construction of the model.—*L'Eclairage Elec.*, October 29.

Train Resistance.—Davis.—A continuation of his former study on a train resistance formula. The motor losses, being easily determined from tests of the motors, are not considered in the discussion. The friction of the bearings can be expressed by the formula, $b + cV$, and rolling friction by $c'V$. Air resistance varies as V^2 with a coefficient depending upon the shape of the car, number of cars in train, etc., but which in railway work will vary from .0024 to .0035. He presents several formulæ for train resistance under different conditions.—*St. R'y Jour.*, December 3.

REFERENCES.

Interurban Road.—An illustrated article on the Scioto Valley Traction Company, which is an interurban line in Ohio and the only one in the State operated by third rail. When completed the total length will be about 45 miles. The third rail is of steel, and weighs about 110 pounds per meter. The cars are equipped with four 125-hp motors controlled by the multiple-unit system. Power is generated at a central station located near Obetz Junction and is transmitted at 27,000 volts, three-phase, 25 cycles to three sub-stations. The high-tension conductors are of aluminum.—*St. R'y Jour.*, December 3.

The Autographic Test Car.—Herrick.—A description with diagrams of the apparatus used on his car to autographically test and record the resistance of all rail bonds in the track and to mark those having an excess of resistance. The car is also used for testing the efficiency of and locating the defects of other motor cars.—*St. R'y Jour.*, November 26.

Block Signals on Single-Track Roads.—An editorial on block signals on single-track roads. When extra cars are required it is a question whether to run them between the regular cars or directly behind regular cars. The first plan requires extra turnouts and introduces a new time table; the second prevents block signal protection between each group of two cars. Possibly the most desirable plan is the multiple-unit.—*St. R'y Jour.*, November 26.

Wires, Wiring and Conduits.

Maximum Currents Permissible in Direct-Current Cables.—Krath.—The report of the committee appointed by the Union of German Electricity works and by German cable manufacturers, and adopted by the German Association of Electrical Engineers. He describes the work done by the committee. They arrive at the following formula for the maximum current which may be allowed in single direct-current cables:

$$J = c\sqrt{\frac{g\,t}{\log\frac{4\,l}{d}}}$$

In this formula, J is the maximum current permissible; c is a constant, the value of which was found from numerous experiments to be 11.55; Q is the cross-connection of the copper core in sq. mm.; t is the increase in temperature in degrees C. of the cable core; this is taken as 25° C. in calculating the following figures; l is the depth in mm. below the surface where the cable is laid; l is taken equal to 700 mm. in the following figures: d is the diameter in mm. of the copper core. The following table gives the figures for direct-current cables laid in earth up to 700 volts, the first figure giving the cross-section, the second the maximum current permissible:

16 sq. mm.	140 amp.	185 sq.mm.	530 amp.
25 "	175 "	240 "	615 "
35 "	215 "	310 "	705 "
50 "	260 "	400 "	810 "
70 "	315 "	500 "	920 "
95 "	370 "	625 "	1,040 "
120 "	420 "	800 "	1,190 "
150 "	475 "	1,000 "	1,350 "

It is said that the current given in this table should not be surpassed under any circumstances. The figures hold good as long as there are not more than two cables in close proximity in the earth. Neutral wires are not considered as cables. If the conditions for the dissipation of the generated heat are unfavorable—for instance, of the cables are arranged in conduits, or if a great many cables are crowded in the earth—it is recommended to make the permissible current three-fourths the value given in the above table.—*Elek. Zeit.*, November 17.

REFERENCES.

Heating of Cables.—Teichmüller.—A paper in which he follows the theory developed by Kennelly and develops a formula for the permissible current in a cable to insure that the temperature does not rise beyond a certain value. He says that former formulas of this kind (including the committee formula in the preceding abstract) are more or less empirical, while his formula is based on an exact theory and takes into account all important quantities without being very complicated. His formula agrees well with actual measurement.—*Elek. Zeit.*, November 3.

Cable Laying.—Andrews.—A concise discussion of the relative advantages and disadvantages of the following methods of cable laying: Armored cables laid direct in ground; laid solid in troughs, filled with bitumen; drawn into iron pipes; common earthenware pipes laid direct in ground; moulded concrete; high-class earthenware ducts; high-class earthenware laid solid in concrete; ordinary bitumen ducts; fibre conduit laid solid in concrete. The latest system is comparatively new in England, though it has been used in the United States for about 10 years. The only disadvantage of the same mentioned by the author is that it is not quite so cheap as common earthenware pipe.—Lond. *Elec. Eng.*, November 18.

Ionization Produced in Gases by Penetrating Röntgen and Radium Rays.—EVE.—An article pointing out that evidence is gradually accumulating in favor of the view that the γ rays and Röntgen rays are identical in their nature. The evidence to this effect is twofold: First, the γ rays are not deflected by a magnetic field. Second, in the changes of radium the β and γ rays always appear together and in the same proportion. This result is to be expected if the γ rays are produced by the β. In any case the present paper removes an objection to this view. It is true that methyl iodide remains as a marked exception to the density law, but it is probable that harder rays than those employed would bring this vapor into line with others.—*Phil Mag.*, November.

ELECTRO-PHYSICS AND MAGNETISM.

Slow Transformation Products of Radium.—RUTHERFORD.—The author has formerly shown that radium undergoes disintegration through a series of well-marked stages. The radium first of all produces the radium emanation, and this in turn is transformed into an active deposit, which behaves as a solid, and gives rise to the phenomena of excited activity. This active deposit undergoes three further rapid transformations. For convenience the products in the active deposit are termed radium A, radium B and radium C, respectively. The change from A to B is accompanied by α rays alone, the change B into C is a rayless change, while the change C into D gives rise to α, β and γ rays. The author now shows that there is very strong evidence that there are at least two more slow transformations leading to what he calls radium D and radium E. Radium C gives rise to the β ray product, which he calls radium D, while radium D changes into the α ray product, which he calls radium E. The product radium D gives out only β rays. The time required for each transition product of radium to be half transformed into the next one given below it in the following table is as follows:

Radium, about 1,000 years.
Emanation, 4 days.
Radium A, 3 minutes.
Radium B, 21 minutes.
Radium C, 28 minutes.
Radium D, about 40 years.
Radium E, about one year.

D and E substances are separable in two different ways, which are described.—*Phil. Mag.*, November.

REFERENCES.

Radioactivity.—STRUTT.—A note giving the results of some observations of the presence of radium in 17 various materials. Distinct radioactivity appears to be much more common in saline residues of waters than in rocks.—*Phil. Mag.*, November.

Ionization.—WALKER.—A paper on the theory and measurement of saturation currents in ionization.—*Phil. Mag.*, November.

ELECTRO-CHEMISTRY AND BATTERIES.

Ozonizer.—An illustrated article on a new ozonizer devised by Rosenberg. As shown in Fig. 2, each element of the ozonizer con-

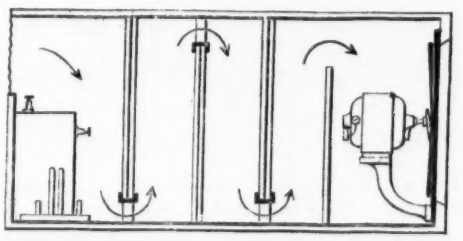


FIG. 2.—OZONIZER.

sists of a thin sheet of highly insulating material, such as micanite, against which are applied, on either side, sheets of copper gauze having 40 meshes to the inch. These sheets are connected alternately to the two poles of the step-up transformer, which gives a potential difference of 4,500 volts, this having been found by experiment to be the best pressure for the purpose. It will be seen that the current of air drawn through the ozonizer by the fan is constrained by the arrangement of the elements, acting as baffle-plates, to pass over the whole of the ozonizing surfaces, which have an area of nearly 4 sq. ft. in the apparatus in question. "As at each corner of each mesh of the gauze the wire is necessarily bent, so as to form an elevation, which may be regarded as a rounded point, there are 234,400 such points to every square foot of the ozonizing surface, or a total of over 900,000. From each of these a discharge takes place upon the surface of the dielectric; but, owing to the extreme subdivision of the discharge, there is no sparking whatever, and hence no nitrous compounds are formed." The ozonizer is stated to be capable of ozonizing 30,000 cu. ft. of air per hour, with the expenditure of 60 watts, including the losses in the rotary converter.—Lond. *Elec. Rev.*, November 11.

REFERENCE.

Copper Plating.—MAXIMOWITSCH.—To get a good electrolytic copper deposit in a short time, that is, with a high current density, it is necessary to stir or heat the solution. The reason is that fresh copper ions must always be brought in contact with the cathode. The author remarks that the same result can be obtained if the electrodes are not arranged vertically but horizontally, the anode being above the cathode. The heavier copper sulphate solution is then always sinking downward to the cathode.—*Elektrochem. Zeit.*, November.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Units.—SCHREBER.—A paper on force, weight, mass, matter and substance. According to the author substance is everything which does not change in quantity in a given system; energy, mass, electric quantity are substances. Matter is characterized by undergoing chemical reactions; it is the capacity factor of chemical energy. He then discusses force, weight and mass and thinks the sharpest definition of force can be given as follows: If two bodies, alone in space, are acting on each other, accelerations are observed which have a constant ratio at all times and in all positions. The reciprocal value of this ratio is called the ratio of the masses. If we designate the mass of one body as the unity of mass the mass of all other bodies is determined. This definition does not use the conception force. Force is a derived conception, being the product of mass and acceleration. The above definition of mass, while strictly correct, does not give a good idea of the term; the same is, therefore, the case with force, since this is a derived term. The author prefers to make force the fundamental conception, and defines it as that physical quantity which man can replace by an exertion of his muscles. Weight is a special form of force, being the attraction of a body by the earth and is different at different points of the surface of the earth. For this reason, it cannot be used for the definition of the unit of force. He proposes to base the definition of force upon Newton's law of gravitation. He defines as unit of force the force with which two globes of water, each of one c.c. volume, at maximum density, attract each other when their surfaces are just touching each other. He proposes to call this *is* from the Christian name Isaac of Newton. This unit of force has the same value everywhere in space. The unit of mass is the mass of one c.c. water at maximum density. His unit of force is very small for practical purposes, since one kg. weight is about 2.263×10^{13} *is.*—*Dingler's Polyt. Jour.*, October 22.

New Phase Meter.—SIMON.—A description of a new phase meter which is applied to the transmission of the indication of the compass to a distance on board of iron vessels. The phasemeter is based upon the well-known optical principle that two circularly polarized vector fields of the same amplitude, but opposite direction, when superimposed, combine to form a linearly polarized vector field whose azimuth only depends upon the phase difference of the rotating fields. If two magnetic rotating fields are thus superimposed a magnetic alternating field is obtained which is steady in direction for any given phase difference, but rotates through an angle equal to half the difference when the phase is altered. A Braun cathode tube may be used for demonstrating the principle, but the author prefers some arrangement like that shown in Fig. 3, where a small mirror is attached normally to the end of a thin steel rod with the alternator. On board ship the author purposes the following arrangement for the transmission of the direction of the earth's horizontal magnetic force; in other words, the compass reading. Two coupled polyphase generators have their axes normal to each other. The earth's field is used for exciting one of them, i. e., the latter is a polyphase earth inductor. The other is excited independently. The

field of one generator is, therefore, fixed with respect to the vessel, that of the other is fixed in space. If both armatures are coupled the position of the vessel with regard to the magnetic meridian determines the phase difference of the two rotating fields, and that

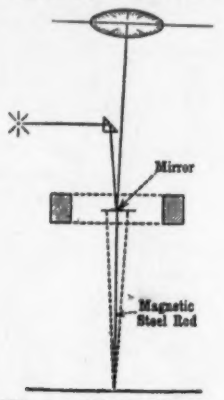


FIG. 3.—PHASE METER.

phase difference can be indicated on the bridge or in any part of the vessel where a compass cannot be placed. The main idea recalls the proposal of Weber to use the earth inductor for this purpose, but that proposal seems to have met with prohibitive practical difficulties.—Lond. *Elec.*, November 18; from *Phys. Zeit.*, October 20.

REFERENCE.

Magnetization of Iron in Bulk.—THORNTON.—The full Physical Society paper, an abstract of which was recently noticed in the Digest.—*Phil. Mag.*, November.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Selective Wireless Telegraphy.—BULL.—An illustrated article on some tests made before the United States Navy between the stations at Highlands of Navesink, N. J., and Brooklyn Navy Yard, the distance being about 22 miles. The waves had to pass over the greater part of Brooklyn. The regular service is by means of the Slaby-Arco system. In the Bull system secrecy was obtained by using a series of three impulses at intervals of 0.063 and 0.295 second, the interval between successive series being 0.2 second. It is stated that the official demonstration took place on May 12, and that communication with the Slaby-Arco instruments seemed to be strongly effected by slight atmospheric disturbances, while they had very little effect on the selective signaling. The reason is claimed to be that interference is to a certain extent eliminated in the Bull system, since in order to put the selective inker into action, at least three wave impulses, correctly timed, are necessary. As long as therefore the interference is only moderate it does not affect the selective receiver, although it may be strong enough to make correspondence with ordinary wireless instruments an impossibility.—Lond. *Elec.*, November 11.

MISCELLANEOUS.

Presidential Address.—SIEMENS.—His presidential address to the British Institution of Electrical Engineers. He emphasizes that modern civilization and all industrial developments have their true foundation in the lowering of the cost of production. For "internal working," every industry depends upon three principal factors: (1) The capital which provides the works and the raw material. (2) The workman who converts the raw material into the finished product. (3) The management. Taking capital first, its share in the value of the finished article is proportionate to: (*a*) The cost of the depreciation and maintenance of the works and of their outfit. (*b*) The cost of the raw materials. (*c*) The profit, representing interest on the total capital invested in the undertaking. He thinks that a particularly dangerous way of increasing capital expenditure is buying patents; it is much more equitable to remunerate an inventor by a royalty, so that his reward may be in proportion to the success of his invention, and to charge the amount that may have to be expended in developing the invention to revenue account. In considering the workman he emphasizes that it is quite certain that in order to contribute his share to the lowering of the cost of production of an article, the workman has to turn out a greater number of these articles in a given time, and the problem is how to attain this object without endangering the interest of any one of the three principal factors. Most important is the substitution of machine work for hand labor, and where this is done unskilled labor should be utilized for running the machines under the supervision of a few skilled artisans. He deals at some length with the problem of labor unions. Under the third term, "management," he includes everything which appertains to (*a*) the selection of site for works, their planning and their equipment; (*b*) the commercial work connected with the business; (*c*) the arrangements for carrying on operations; (*d*) the designing of new apparatus and the investigation of new methods of manufacture. A good design should have for its aim the lowering of the cost by employing simple component parts which can either easily be obtained or cheaply manufactured. The first requirement is fulfilled by utilizing standard sizes. The author then made a strong plea for the metric system; this part of his address is dealt with elsewhere in this issue. He finally spoke of the patent situation and said it is a fallacy to consider a preliminary examination as practiced in the United States to be of any advantage to an inventor. It is the business of an inventor to find out for himself what has been done before, and to make himself thoroughly acquainted with his subject before he begins to suggest improvements. In this work he should be assisted by the staff of the Patent Office, where a reference library for technical subjects should be at his disposal, containing not only patents, industrial designs or models and trade-marks, but also files of the principal technical and scientific periodicals and transactions. "Searching such records will prove to be a liberal education."—Lond. *Elec.*, November 11.

Repair Shop.—EMERSON.—The first of a series of articles on systematization and tool-room practice in a railway repair shop. He discusses standardization and general organization.—*Eng. Mag.*, December.

New Book.

TRANSACTIONS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION. Twenty-seventh Convention, Boston, May 24, 25, 26, 1904. New York: James Kempster Printing Company, 2 vols. 650 + 588 pages.

The new life which in recent years has been infused in the National Electric Light Association is most notably manifested in the *Transactions* of that body. This publication, covering the year 1904, consists of two volumes, containing an aggregate of over 1,200 pages. A new feature introduced in the volumes consists of briefs of the papers read before the association and of reports adopted. The briefs follow the names of authors and chairmen of committees reporting. A preferable arrangement would be to classify the briefs by subjects, but where the number of subjects is relatively small, as in this case, the great value of the system is but slightly affected by the arrangement adopted.

The first volume contains about 30 papers and reports of committees. Many of the papers are of the commercial type, but of the residue quite a few stand out as excellent contributions to practical central station engineering. Among these are the papers by Frueauff on office methods of accounting; Atkins, Bushnell and Brine on factory electric power service; Eastman on grounding the neutral; Eglin committee report on the present status of the steam turbine; Humphreys on lost and unaccounted-for current; Rhodes on the organization and equipment of an arc lamp department; Vredenburgh on advertising methods; Williams on decorative and sign lighting, and Hancock on underground construction. The latter paper, to which was awarded the Doherty gold medal, loses some of its value through apparently having received little care with respect to logical arrangement or literary execution.

The second volume is almost totally given up to the "Question Box" and department of "Wrinkles." The industry of the editor of the former, Mr. H. T. Hartman, can be appreciated in looking through the 400 odd pages of answers contributed by more than 200 persons having special knowledge on the subjects of the questions to which they replied. As many answered a number of questions and almost all questions relate to subjects of practical and timely value to central station men, the value of this department to the members of the association is of the highest. The department of "Wrinkles" includes 103 contributions relating to home-made devices, practical methods, etc., which have been devised or come under the observation of the writers. These two departments alone are amply sufficient to justify even the smallest central station paying the fee necessary to become a member of the national body representing the electric lighting industry.

The Cockerill Gas Engine in America.

The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, has become the sole licensee for the Cockerill gas engine, which, during the past six or seven years, has had a great success in Europe. Of this type 121 have already entered into use there, aggregating nearly 80,000 hp in units of from 200 to 3,000 hp. It is especially adapted for heavy-duty electric light and power work, as well as for blast furnace blowing engine work, in which latter service it consumes blast furnace gas.

The design of the cylinders in the Cockerill engine presents the following features: Owing to the considerable differences in temperature occurring in the cylinder, it is necessary to provide for free expansion, and this is obtained by supporting the cylinder in a cradle, one end only being attached to the main girders of the engine bed. The power of each end of the cylinder is transmitted through the girders to the engine frame, as the two heads of each cylinder are connected by through-going bolts, and the power developed in the back end of the cylinder is transmitted through these to the front end. The cylinder proper is, therefore, not subjected to the stresses incidental to power transmission.

The pistons are steel castings in one piece and secured to the piston rod by means of a collar and nut. No taper is used on the rod, and the wedge action caused by tightening the nut, and thereby tending to split the piston, is avoided. A special feature of our engine is the water-cooled piston rod nut, which is an additional preventive to premature ignition. The pistons do not bear in the cylinders, but are supported outside the cylinders by cross-heads.

All valves of each cylinder end are operated by a single cam; therefore, in a four-cylinder, double-acting gas engine there are only eight cams in all. The valve gear, though performing the regulation of the mixture in a perfect manner, is of the greatest simplicity, and consists of a very few parts in motion. The side shaft, driven by the engine shaft, making one revolution to two of the latter, because of the four-cycle principle, carries a cam for each cylinder end, which serves for operating both the inlet and outlet valves. The inlet valves are situated on the top and the outlet valves on the bottom of the cylinder, and are designed for easy accessibility.

The regulation is effected by a governor, which controls the admission of the mixture of gas and air in either of the following ways:

First, by automatically cutting off or by throttling a constant mixture, either of which produces variable compression. Second, by varying the relative volumes of air and of mixture, the latter always following the former, this method resulting in constant compression.

From the moment of the opening of the gas valve, which corresponds to a certain predetermined position of the piston during the suction stroke, air and gas in proper proportions are admitted so as to give a good mixture. Whatever, therefore, the moment of cut off may be, the proper quantity of gas and air for a good mixture is admitted. The two valves and the slide remain open until the end of the suction stroke. At this moment a large spring closes the mixing valve and the air slide and a link returning to its original length closes the gas valve. A small spring, *s*, is introduced so as to permit the mixing valve, *M*, to continue its motion and seat itself should the valve, *V*, touch its seat before *M* can close.

The piston on its return stroke compresses the charge, the inlet and outlet ports of the cylinder being closed, but as the variable quantity of mixture *followed* a certain volume of air and completed the 100 per cent. of cylinder volume, the best mixture remains close to the igniters located in each cylinder head, and therefore firing is assured even with the smallest load.

A little before the dead center corresponding to the end of the expansion stroke, the lobe of the cam, *C*, touches the roller, *t*, and acts by means of the rod, *U*, and the levers, *W* and *X*, upon the exhaust valve, *Y*, opening the same. This valve remains open during the exhaust stroke (second return stroke of the piston), and is

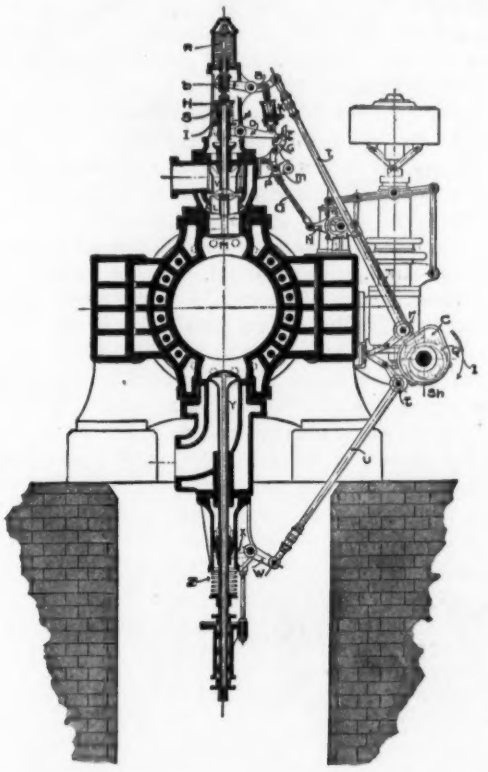


FIG. 2.—VALVE MECHANISM.

closed on the dead center corresponding with the beginning of the next suction stroke by means of the spring, *Z*, which acts at all times to close the valve and presses the roller, *t*, against the cam, *C*.

By this latter method the mixing valve remains lifted up during the entire suction stroke. The gas valve opens at a certain point during the suction stroke, and remains open until nearly the end of same. The point of opening is variable, and is determined by the governor at all times; and the quantity of gas admitted is in exact proportion to the load of the engine, and the compression remains constant.

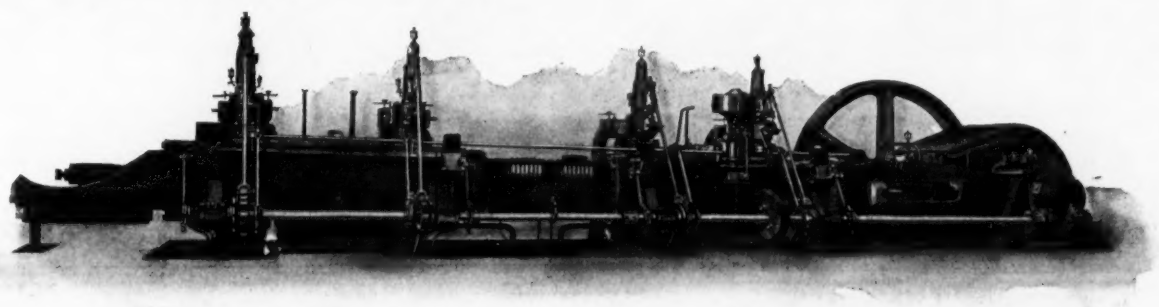


FIG. 1.—GENERAL VIEW OF COCKERILL GAS ENGINE.

The engines are constructed in view of the heavy duty which they perform, and only first-class material is used. Provisions are made for free expansion of the cylinder liners; cylinder heads can be easily removed in order to inspect the piston without dismantling any part of the valve gear. The engines are provided with magneto-electric igniters of the most improved system. The starting of the engine is effected by compressed air.

New Underwriters' Laboratories.

The Underwriters' Laboratories in Chicago, on 21st Street, is to have new quarters within a year. The corporation has leased for a period of 99 years a site for a building to be used as a laboratory, on Ohio Street. The new building will cost $15,000.

The Works of the Power & Mining Machinery Company.

In former days a manufacturing plant "just grew," about the only provision made for the future being the purchase of a larger site than immediate necessities required. In recent years, however, there has been a marked change in this respect, and nowadays a plant is initially as carefully designed as an engineering project, not only with respect to the relations of each of the separate departments, but also with respect to every minute detail affecting cost and output.

A notable recent plant illustrating in detail the most modern practice in engineering works design is that of the Power & Mining Machinery Company, of Cudahy, Wis. As completed, it embodies all the modern labor devices that apply to the lines of work to be carried on. The buildings are arranged with reference to each other to minimize the handling of material, and the machinery has been located with the same end in view. For the handling of material the latest power devices have been installed, and the buildings were designed to secure the best conditions with respect to ventilation and light, the roof skylights being inclined at a proper angle to the north to secure the best lighting effect and shut out the direct rays of the sun. The plant was designed for the construction of the Loomis-Pettibone gas apparatus, American-Crossley gas engines and mining machinery.

All of the main buildings are heated by means of warmed air, which, after passing around steam coils, is forced by a fan 12 ft. in diameter through distributing pipes in the building, which are carried overhead along the side walls. The artificial lighting is mainly by enclosed arc lamps, of which more than 250 are in use; 220-volt incandescent lamps are also in service, with many outlets on posts and walls provided with receptacles into which plugs with attachment cord may be screwed when a lamp is desired temporarily at any point. A fire pump with a capacity of 1,000 gallons per minute maintains a pressure of 100 pounds per square inch in a system of pipes running throughout the yards and buildings. Hydrants placed at various points about the yard are connected with this system, which is also connected with risers within the buildings having hose permanently attached. A fire alarm system with boxes in the various buildings operates a whistle in the power house, and the workmen have been organized into a trained fire department.

A network of railway tracks connects the various parts of the works. Within the separate buildings these run under crane ways, which lift heavy parts from cars and deliver them where desired. A 20-ton gantry crane with a span of 65 ft. serves the storage yard, conveying heavy material to and from the several tracks serving the buildings and loading railway cars for shipment. Cranes are also placed over both a die storage yard and an iron storage yard. In addition to these outside cranes and numerous jib cranes, nine others of the overhead type are installed in the different buildings.

A three-story building contains the offices of the plant on the lower floor, where there is also a private telephone exchange with connections to all portions of the plant and to the Milwaukee and long-distance telephone systems, as well as a telegraph office with connections to the Western Union and Postal Telegraph lines. The second and third floors are occupied by the engineering department, which employs constantly more than 30 draughtsmen.

The machine shop is 552 ft. long with a maximum width of 162 ft. The central bay is 42 ft. in height, on either side of which for the greater portion of the length are bays 32 ft. wide. Connecting on the south side is a wing 217 ft. long with a width of 82 ft. Two cranes of 20 tons each serve the central bay and the extension on the south is provided with a 3-ton crane. The western section of the central bay is utilized as a testing floor for gas engines, cast foundation plates on concrete foundations being provided for this purpose.

All tools in the machine shop are driven by General Electric motors. In some cases one motor operates a group of several machines by means of line shafting, but the larger machines are driven by individual motors, in some cases the motors being directly geared to the machines and in others belts and countershafts are employed. Among the notable machines is a slotter built in the plant, having a stroke of 5 ft., and which will finish the ends of work 12 ft. in length. Two worm and spiral gear cutters built in Germany are located in the southern wing and a cam-cutting machine built in Manchester, England, is used for cutting the cams of gas engines. There is a boring machine having a clear swing of 15 ft., a lathe with a 54-in. swing and another with 24 ft. between centers.

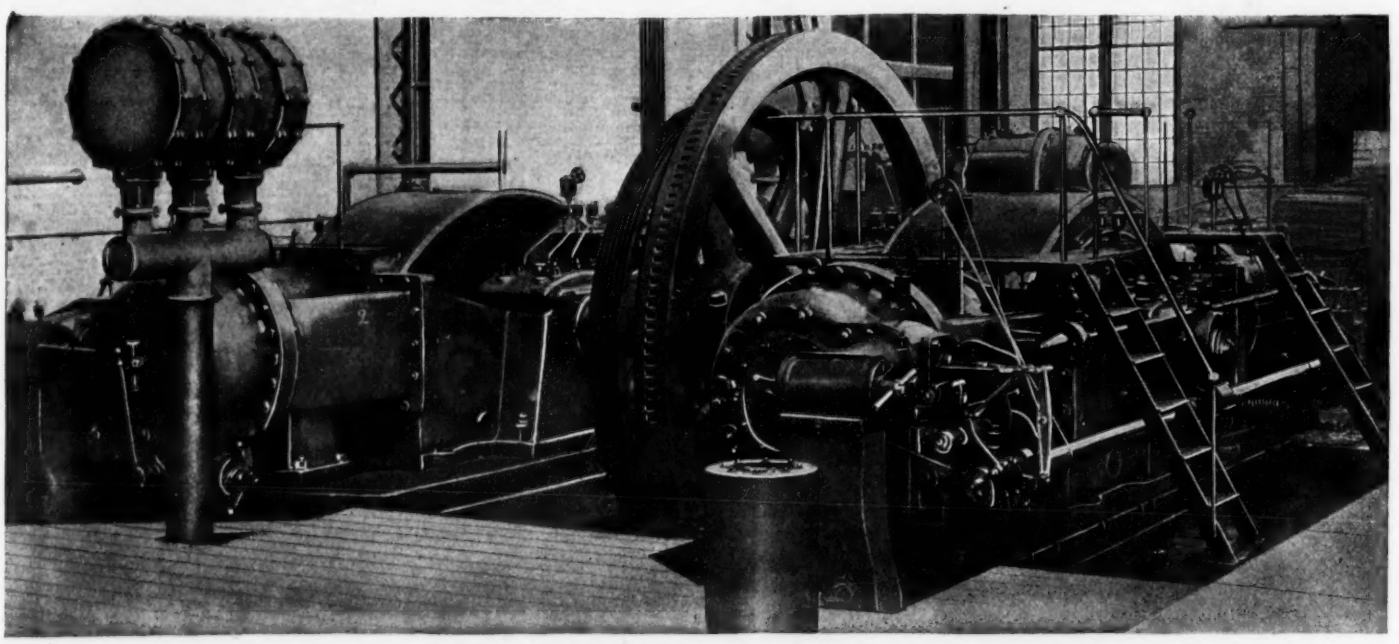


Fig. 1.—1400-hp Four-Cylinder Gas Engine.

The boiler shop, which runs parallel to the machine shop, is served by two overhead cranes of 20 tons capacity and 40 ft. span, while jib cranes are located at convenient points for serving machines and handling smaller material. Among the larger machines are a flange press of 130 tons capacity, plate bending rolls with a capacity for rolling a plate 2¼ in. thick, and two hydraulic riveters with a gap of 11 ft. 6 in., and working under pressures of 33, 67 or 100 tons. Among the punches is one which at one stroke will pierce 45 holes into a plate ½ in. thick. All the machinery in the boiler shop, with the exception of the hydraulic cranes, is electrically-driven and with a few exceptions has individual motors. Among the notable pieces of work turned out of this shop has been a pipe line for the Guanajuato transmission plant in Mexico having a length of 3,300 ft., the pipe having a diameter of 69 in. and varying in thickness from ⅝ in. to 7/16 in. Another was a pipe line for Colorado, 15,000 ft. long, the lower portion being built to stand a pressure of 2,000 pounds per sq. in. This pipe is 21 in. in diameter, its thickness varying from ¾ in. to No. 8 sheet metal gauge.

In the forge room all heat is furnished by water gas piped from the power plant. Among other buildings are a sheet metal shop, pattern storage building and foundry. The latter is supplied with

three overhead cranes which serve the entire floor. The two on the main craneway have a span of 65 ft. and are of 30 and 15 tons capacity, respectively, the larger being provided with a 5-ton auxiliary hoist. An 8-ton crane with a span of 40 ft. serves the remainder of the foundry. Castings weighing 50 tons have been poured in the foundry. For blowing out moulds, running the moulding machines and chipping castings compressed air is drawn from pipes dropped down posts at convenient points.

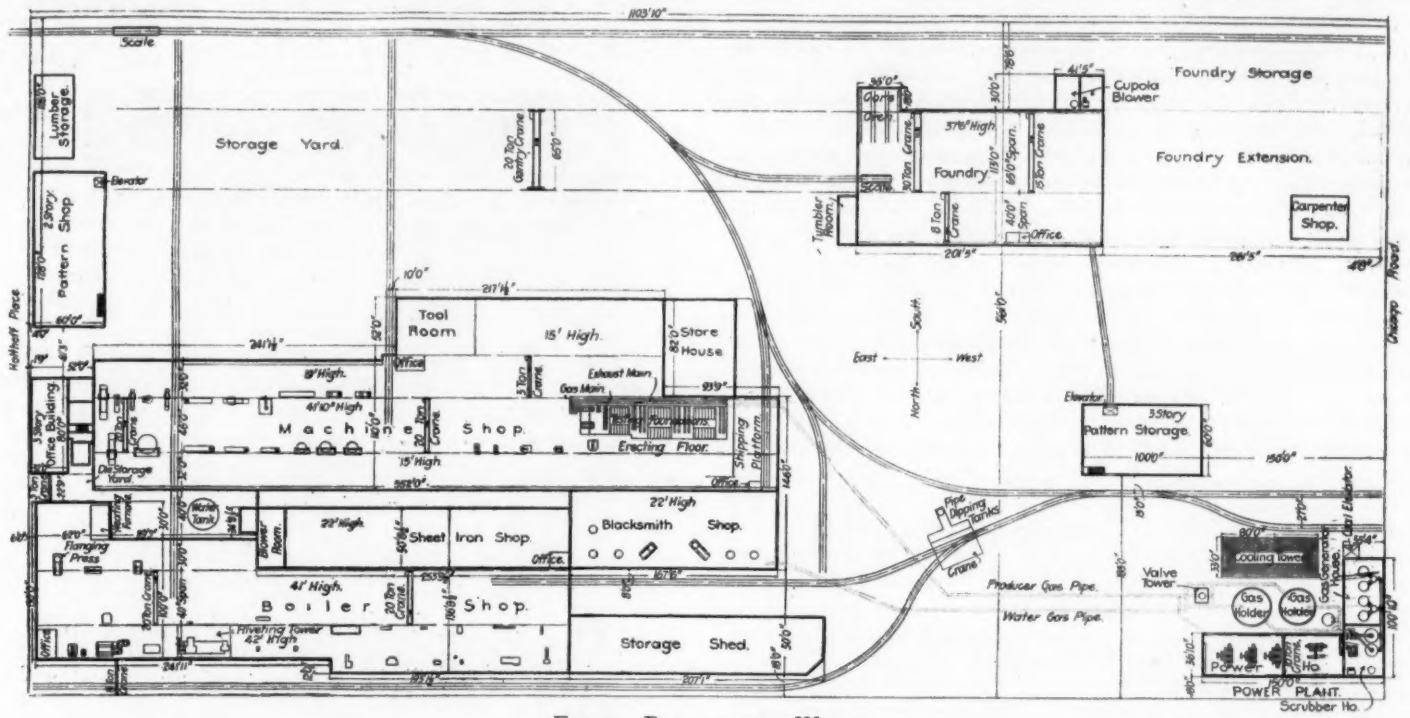


FIG. 2.—PLAN OF THE WORKS.

At the juncture of the two extensions is a room containing the foundry. Castings weighing 50 tons have been poured in the erators and switchboards and a gas engine-driven air compressor.

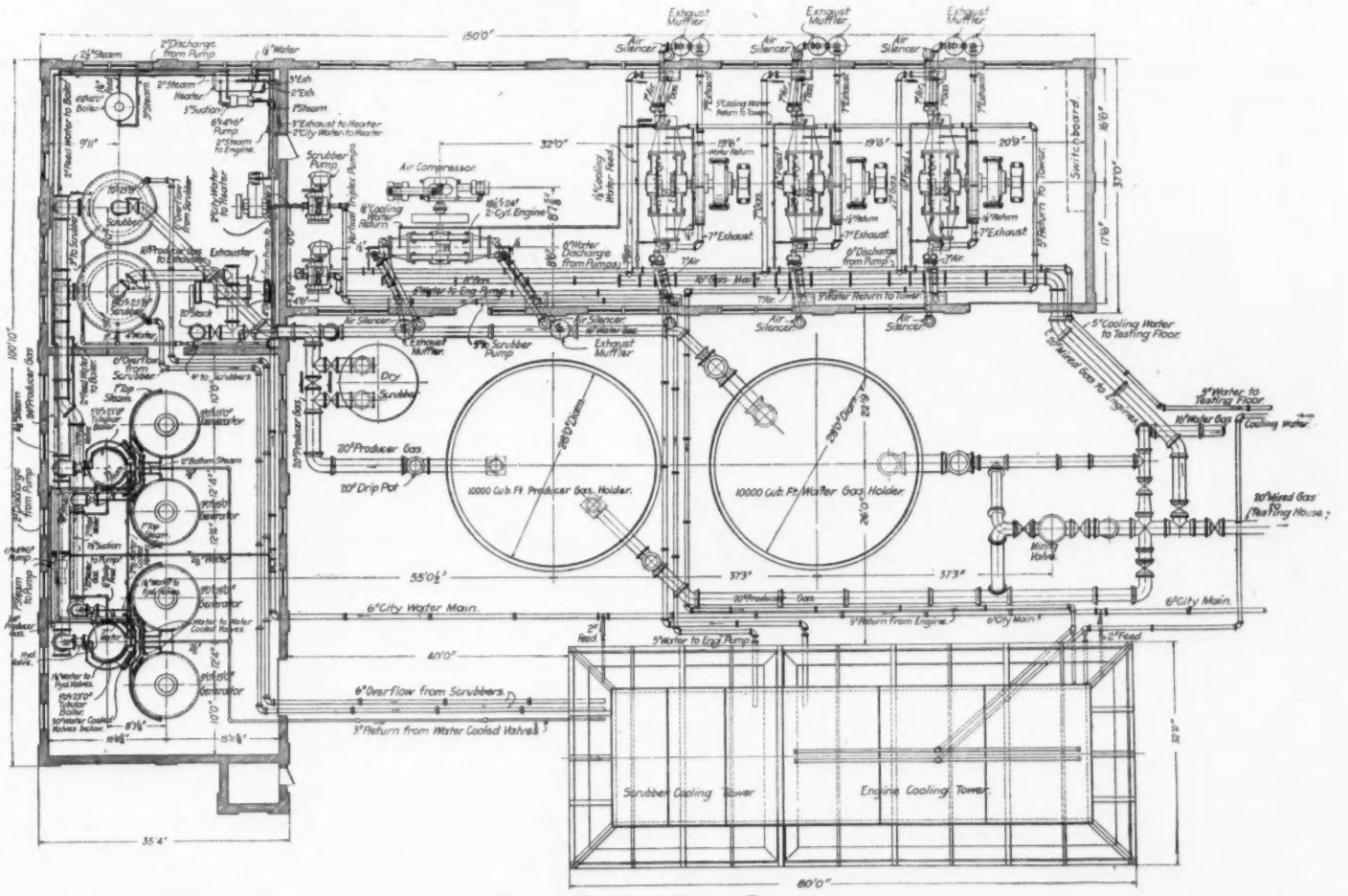


FIG. 3.—PLAN OF POWER PLANT.

The power plant furnishes a working exhibit of the products manufactured by the company. It is located in an L-shaped building, one arm of which contains the Loomis-Pettibone gas producers, boilers, controlling mechanism and coal-handling apparatus. The other arm is occupied by the American-Crossley gas engine generators and switchboards and a gas engine-driven air compressor. At the juncture of the two extensions is a room containing the scrubbers, exhausters, feed water heater and a small auxiliary boiler. The gas holders, cooling basin and dry scrubber are located in the angle between the two portions of the building.

Either producer or water gas is generated from the same apparatus. A portion is piped direct to the engines in the generator room and

pipes are also laid to the furnaces of the forge and boiler shops and to the testing floor in the machine shop. Four producers having a total capacity of 2,000 hp are provided. These are divided into two generating sets. Two producers operate in connection with one boiler and form a set. The two sets may be operated independently. Each producer measures 9 x 15 ft. and is connected near the base through a 30-in. valve provided with hydraulic control to the boiler operating with it. The boilers, which measure 5 x 23 ft., are set vertically and are designed much after the pattern of an ordinary fire tube boiler, the hot gases from the producer passing through the tubes. Leading from each boiler are two gas mains, that for the producer gas being 24 in., while the other for water gas is 20 in. in diameter. The mains from each of the boilers lead to the bottoms of one of the two wet scrubbers located in the corner room. A main leads from the top of the producer gas scrubber through the engine-driven exhauster. The discharge from the exhauster leads, according to the position of the controlling valve, either to a purge stack exhausting into the atmosphere, or to the dry scrubber located outside the building. A bypass which may be used as occasion may require is provided around this scrubber. A short length of 20-in. main connects the dry scrubber to the producer gas holder, which is of 10,000 cu. ft. capacity. From the top of the water gas scrubber a 16-in. main goes direct to the water gas holder of the same capacity as that for producer gas.

The gas from the producers, in passing through the boiler on its way to the scrubbers, generates steam, which is used for several purposes. In making water gas it is introduced direct into the bottom of one of the producers. A limited quantity is also supplied above the fires of the producer when producer gas is being generated. A 2-in. steam pipe leads to the engine operating the exhauster. The boiler feed pump working in connection with the feed heater, as well as the pump supplying pressure for the hydraulic valves, are also operated by steam.

A 6-in. water main from the water system of the plant enters the power house. A 2½-in. pipe is tapped from this and leads direct to the water-cooled valves between the generators and the boilers. Another branch passes to the 6 x 4 x 6-in. pump, maintaining pressure for operating the hydraulic valves. Water is also supplied to two circulating systems of cooling water. One of these extends between the cooling basin and the scrubbers in which the gas is

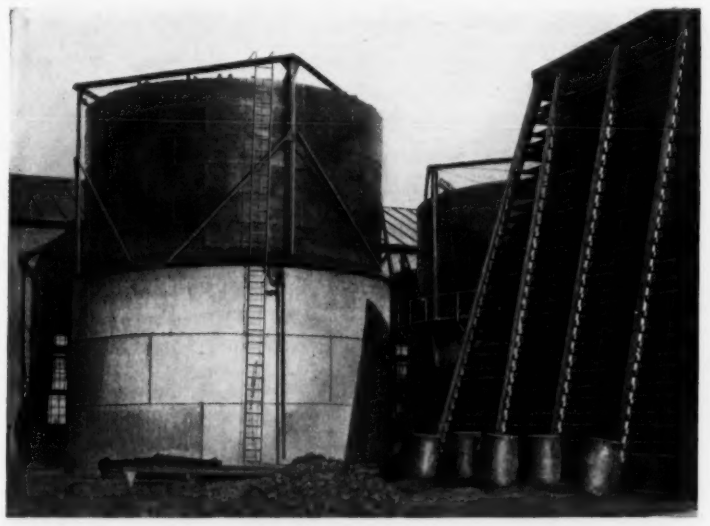


FIG. 4.—GAS HOLDER AND COOLING TOWER.

cooled and cleansed. A direct-connected, electrically-driven pump located near the west wall of the engine room discharges through a 4-in. pipe leading to the top of the two scrubbers into which the water is thrown in the form of a spray. The water having fallen down over the layers of coke in the scrubber, it flows out of the bottom of the scrubbers to the western end of the cooling basin, and after its temperature is reduced it is again pumped through the circuit. A similar pump, also motor-driven and placed near the scrubber pump, circulates water through the jackets of the engines. A 6-in. discharge from the pump runs the full length of the engine room taps leading to the water jackets of the engine being taken off at frequent intervals. The discharge pipe continues through the engine room and to the testing floor in the machine shop. The returns from the jackets pass to the eastern end of the cooling basin shown in the engraving. The two portions of the basin are divided by a solid partition to prevent the mixing of the water of the two circulating systems.

To start the plant when cold the producers are filled with coal to a depth of about 5 ft. This is lighted at the top. The exhauster is then started, steam from the engine being obtained from the auxiliary boiler. The down draft produced by the exhauster soon ignites the mass of coal. More fuel is then added until the bed is about 8 ft. thick. While the fire is getting under way, the gas being of an inferior quality, is allowed to pass off into the atmosphere through the purge stack previously mentioned. After the fires have assumed the proper heat the purge stack is closed, a limited quantity of steam is admitted above the fires and the producer gas generated is exhausted into the holder. If desired, producer gas may be made continually, but usually the requirements of the furnaces and forges are such that the generation of producer and water gases is alternated at periods of from 10 to 20 minutes. To make water gas a few changes are necessary. The charging doors of the producers are screwed down tightly. The water gas scrubber is connected with the boiler and the connection with the producer gas scrubber closed by the operation of hydraulic valves. The 30-in. valve between the boiler and the bottom of one of the producers is also closed. Steam is then admitted to the bottom of the producer, whose connection with the boiler has been closed. The pressure forces it up through the fire of the producer, through a pipe connecting the two producers at the top and down through the live coals of the other producer. It then passes as gas through the boiler and scrubber to the gas holder.

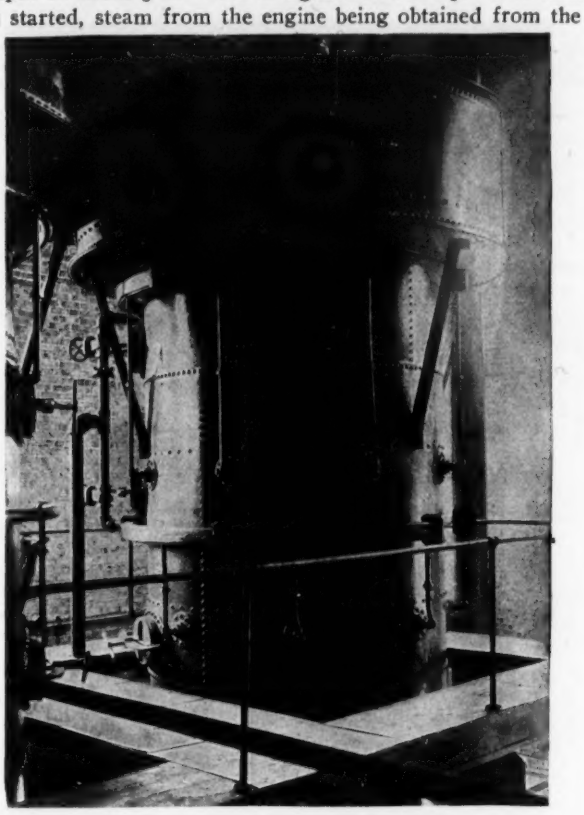


FIG. 5.—UPPER PART OF WET SCRUBBERS.

The steam soon cools the fires to a point at which they do not decompose the steam. The proper valves are then opened and closed and producer gas is generated until the fuel is brought to incandescence. When water gas is again generated, steam is introduced into the second producer and its path through the two producers is thereby reversed. This enables the raw steam to come in contact with the fire least cooled by the previous operation. As stated before, two producer sets are installed. One is run until the ash or clinker in the producer limits its capacity. The other set is then fired, the scrubber connection to the old set being closed. By means of the cleaning doors at the grate level, the old producers are then emptied and cleaned, when they are again filled and are ready to be fired. About 80 tons of bituminous coal can be consumed before cleaning is necessary.

The engine room is to contain three 22 x 30-in., two-cylinder American-Crossley gas engines, each direct-connected to a 150-kw,

250-volt, direct-current generator. A smaller engine of the same general design will operate an air compressor supplying air to the surrounding shops. Gas for the engines will be supplied through a 20-in. main. The connections are such that either all water gas, all producer gas or any desirable mixture of the two may be supplied to the engines. The arrangement of the pipes may be seen by reference to the plan.

The leads from the dynamos will be run through vitrified clay conduits under the cement floor to the switchboard located along the eastern wall of the engine room, through which are distributed the sixteen lighting and power circuits leading to the several shops. In all about 50 motors varying in size from 50 to 3 hp are employed. The larger of these are of about 28 to 30 hp. The power load is about 66 per cent. of the total, the remainder being consumed in the 250 arc lamps used in lighting the shops.

The American-Crossley gas engines, manufactured by the company, are made with single cylinders up to 150 hp. Two cylinder engines range in power from 180 to 645 hp, while those of four cylinders are rated at from 360 to 1,400 hp and larger. After assembling each engine is given a thorough test under load. After the engines have been assembled on the testing blocks the bearings are worn down by a run without load of from one to four days' duration, depending on the size of the engine. The supply of water to the jacket of one of the cylinders is then shut off, the jacket being filled with water, and another run is made. The engine is kept running until the heat expands the piston so that it rubs on the cylinder walls. The piston is then removed and the spots where the rubbing has taken place are scraped down. This process is repeated until the engine runs freely with water boiling in the cylinder jacket. The other pistons are then fitted in a similar manner. Next the cams are given their final finish. When cut an allowance of ⅛ in. is left on these so that variations in keying them on the shaft may be corrected. The corrections necessary are found originally by studying indicator cards of the engine. Afterward it is sufficient to note the position of the piston. After the corrections required are found the cams are filed down to proper shape while on the shaft. The final tests are made by separate runs under one-fourth, one-half and full load, each run being of two hours' duration. Occasional readings are taken of the heat value of the gas, these being obtained by the use of a Junker calorimeter. This enables the thermal efficiency to be computed.

Among the engines recently tested is one built for the Elmira Water, Light & Railway Company, of Elmira, N. Y., which will be direct-connected to a generator. The engine is rated at 1,400 hp and has a 36-in. stroke, the cylinder diameter being 32 in. A flywheel 13 ft. in diameter is provided. A notable feature of the engine is the method of constructing the water jacket. The inner metal surrounding the combustion chamber is cast separate from the outer. Lugs are cast on the outer and inner walls of the two shells. These are drilled and tapped and binding stays inserted, which tie the shells together. This method of construction is used in order that casting strains, blow holes and other defects may be avoided.

Each cylinder is fitted with a weighted fly-ball governor, which varies the mixture in the cylinder according to the load carried. A safety gear prevents the engine starting in the wrong direction. Ignition is accomplished by a double ignition tube arranged so one tube may be renewed while the engine is operating. The entire oiling system drains to the crank pit. The engine is built under a guarantee of speed variation not to exceed 2 per cent. from the mean.

Another of the products of the plant is erected in the machine shop, namely, a 100-hp Crossley suction gas producer. The producer proper consists of a cylindrical shell lined with fire brick and fitted with a revolving grate. The gas, after passing to the top of the producer, enters an evaporator, where heat is transferred from the gas to water, forming steam, which enters the bottom of the producer. A hydraulic box through which the gas next passes prevents the gas backing up into the producer. It then flows through a coke scrubber, where it is cooled and cleaned, and then through one of sawdust, to remove any fine ash or other solid matter which may have been drawn through from the producer.

Wireless in Hawaii Election Returns.

Election returns in Hawaii during the recent Presidential campaign were distributed through the islands largely by means of wireless telegraphy.

Automatic and Measured Telephone Equipment at St. Louis.

The Controller Company of America, situated at Section 19, Palace of Electricity, has taken a prominent part in the manufacturing of telephone and measured service equipment. At its exhibit may be seen various kinds of equipment for measured service. Among these is the Stroud collector, a recently perfected invention by means of which the operating companies may offer the benefits of measured service to a subscriber without incurring any drag whatever on the work of the operators. The subscriber simply drops his coin, which he is preferably required to do, in order to call the operator. The coin drops down in front of a window where, if connection is successfully made, it remains in plain view of the subscriber, in whose charge the telephone is placed. Here it remains until the next call is made. This fact alone in a great measure prevents the use of unauthorized slugs. If the subscriber does not get the number called for the coin is returned to him.

This collector is also adapted to magneto systems, being the first collector electrically controlled by the operator and having a coin

FIG. I.—BOOTH OF CONTROLLER COMPANY OF AMERICA.

return feature. The old method of collecting by having the subscriber drop the coin, pull the lever, push the button, etc., to give the operator a signal, has been superseded by this modern, rapid service apparatus. In adapting these collectors to magneto systems no change is made on the switchboard excepting the placing of a small push button. At the subscriber's end the ringing generator is substituted for a kick coil, and the act of dropping a nickel in the slot closes the circuit through the coil, thus throwing the drop and giving the operator the signal.

As the automatic systems are becoming more prominent, they, too, must be equipped with measured service apparatus. The Controller Company of America has recently placed on the market a collector for automatic systems. This appliance is similar to that used on common battery or magneto systems. In operating, the number is selected and called in the usual way. The party answers, but conversation cannot be carried on as the transmitter circuit is open until coin is dropped. However, this does not interfere in any way with the incoming calls, as the transmitter circuit is open only to outgoing service.

A new departure in telephone apparatus may also be seen at the Controller Company's booth. This device consists of a Stroud collector mounted on a pressed steel base or backboard, having an extension below for an adjustable transmitter arm. The hook switch

and coil are mounted on this base of depth enough to contain them. A pair of extra terminals are provided, besides line posts, and at any time the ringers may be connected. This style of telephone is designed for party lines having as many as 20 parties who desire one-way service. The telephone company may place them without guarantee or contract, in places where it is otherwise impossible to install a telephone, and the collections in the cash boxes indicate that sub-

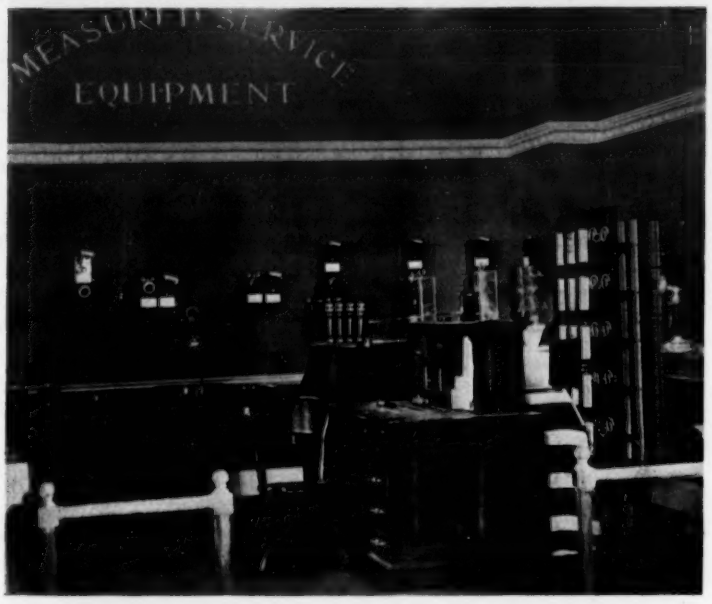


FIG. 2.—EXHIBIT OF CONTROLLER COMPANY OF AMERICA.

scribers use this service sufficiently to warrant such a course. Soon the subscriber becomes educated in the use and advantages of the telephone as a household necessity and sooner or later applies for "both way" service, agreeing to guarantee a fixed sum per month as specified by the company.

Every "Independent" telephone within the fair grounds at St. Louis was equipped with the Stroud collector, which we are told has given perfect satisfaction to subscriber and company alike. In addition to this use, and as part of the Controller Company's exhibit, there was a private exchange providing free service through 100 telephones to exhibitors in the Electricity Building, which telephones also are equipped with the Stroud collector. The method of operating was that the coin was invariably returned to the subscriber to demonstrate the workings of the system.

The Controller Company of America have made a very fine showing at the fair, both in appearance and from an educational standpoint, for in demonstrating both the uses and advantages of measured service, they have helped to educate the public to the belief that measured service is best for both subscriber and telephone company.

Insulator Plant at Lima, N. Y.

The Lima Insulator Company has recently started a new plant at Lima, N. Y., to manufacture line insulators for all classes of service. The location of the plant was selected principally on account of the natural gas fields but a few miles away, and which furnish an apparently inexhaustible amount of gas of high fuel value. The buildings are directly beside the Lehigh Valley Railroad, which affords exceptional shipping facilities to all points, and are arranged so that the raw material can be unloaded at one end of the plant and the finished product shipped from the other with a minimum amount of handling.

In laying out the plant the idea of saving handling has been kept constantly in mind. The result is a workroom in which the various clays are mixed and manipulated almost entirely by the most modern clay-working machinery and then taken to the second floor of the plant by an endless belt. On this floor all the insulators are formed, dried in a steam dry room and glazed. The ware is then taken down an incline to the kilns and landed directly in front of the kiln doors, where it is placed in saggers and loaded. All the fuel used in the plant is natural gas, and by its use a remarkably uniform grade of porcelain is obtained, which can be obtained by no other fuel.

The designs of the insulators manufactured by the company have been very carefully worked out with a view to getting an ample arcing distance together with a maximum leakage surface. These points, together with the great strength of the porcelain used, combine to make an insulator of notable value.

The personnel of the company is composed of men with a wide experience in the manufacture of insulators and with a thorough knowledge of the requirements of the trade, which should insure thorough satisfaction on all insulators. The officers are: W. D. Newton, president; Roy Wellman, vice-president; Eben W. Lathrop, secretary, and M. W. Burke, treasurer.

Arc Lamps With Reflector Globes.

For a long time efforts have been making to secure more light from a given current consumption. This has been done by producing new forms of lamps, and also by carrying out different ideas in incandescent lighting. The old type arc lamp has practically been left alone until the devising of a plan for concentrating the light rays from it. There has now been perfected an arc light lantern and distributer that is being put on the market. This is designed to take the place of the arc lamp globe and to do away with the globe entirely. The structure of the arc lamp is the only thing inside these lanterns or distributers. In the first place, this does away with the concave reflector effect inside the lamp which is caused by the globe. This has been responsible for cutting off of about 20 per cent. of the light rays that would otherwise leave the lamp. In the second place it does away with expensive repairs when the globes are broken. In the third place it permits practically all the light to radiate from the lamp, from the interior of the lamp to the exterior; and in the fourth place it permits the reflection of light and the concentration of light in a particular direction.

Several styles of the lanterns are made, of which one is illustrated herewith. This particular type is made for an enclosed arc with

ARC LAMP WITH REFLECTOR GLOBE.

glass on the three sides and a reflector on the fourth side with a glass at the bottom. This type is used especially outside of a show window, where it directs the light immediately to the window to which attention is called. Another type is made with glass on all four sides, as well as at the bottom.

The third type is arranged for public lighting at the intersection of street and suburban roads. This style has the four-way reflector throwing the light along the roads directly where wanted, instead of illuminating an area immediately adjacent to the lamp. The advantage of this style is particularly apparent for suburban work where the greatest amount of light can be directed along roads instead of being thrown simply in a circle around the lamp.

A fourth type is made which is called a long-distance lantern, and is intended to be used where the lamps are placed at greater distances apart than is usual.

There is a possibility that the glass in these lanterns or distributers may be broken, but a single piece of glass for one of these sides can be replaced for only a few cents, which of course gives a decided advantage over replacing an entire globe in the event of breakage. The structure of the lantern is of steel, giving a very rigid and substantial structure. These devices are being put on the market by Messrs. Bleiman & Palmer, 166 Spring Street, New York.

Test of 500-KW. Curtis Turbine Set.

In view of the great attention being given by engineers to the performance of steam turbines, some particulars of a series of tests carried out on a direct-current, 500-kw Curtis steam turbine set at the Cork Electric Tramway & Lighting Company's station, and which was supplied by the British Thomson-Houston Company, Limited, of Rugby, may be of interest.

These tests were conducted by Charles H. Merz, the consulting engineer to the company. The object of the tests was to ascertain the steam consumption at varying loads, and for this purpose five tests were made at one-quarter load, one-half load, three-quarter load, full load and 25 per cent. overload, respectively. The tests chamber of the turbine and to the body of the condenser. These were generally of one and one-half hours' duration, although the last test at 25 per cent. overload was slightly under one hour. Great care was taken in each case that before the test was commenced all conditions of load, etc., should be absolutely steady.

The weight of condensed steam was measured by a tank and weighbridge, which was tested before and after the test and found to be accurate. Vacuum gauges were connected to the low-pressure gauges were in agreement. Under conditions of full load, however, the vacuum registered in the turbine exhaust chamber was 2 in. lower than that registered in the condenser, showing that the pipe connection from the turbine to the condenser was not sufficiently large. The barometric pressure throughout the test was 30.16 in.

The output of the machine was measured by two ammeters, a standard voltmeter and a recording wattmeter. The figures entered on the log sheet attached are the mean figures of all readings at each load, readings being taken every six minutes. The readings given are the corrected readings after each instrument had been carefully recalibrated against a standard in the Newcastle-upon-Tyne Electric Supply Company's test house.

The tests were started by taking a reading of the wattmeter and by commencing to fill the water tank, and three minutes after the start ammeter and voltmeter readings were taken. Six minutes after the first wattmeter reading a second wattmeter reading was taken and the condensed steam was weighed. Six minutes after the first ammeter and voltmeter readings, second readings of these instruments were taken, and so on. Hence all readings were taken every six minutes, the ammeter and voltmeter readings midway between the wattmeter and condensed steam records.

A general summary of the results of the tests is given by the log sheet herewith. Two steam consumption curves are also given, showing respectively the curve actually obtained and that made out with correction to 28.66-in. vacuum and 115° superheat.

The vacuum and superheat curves used in making the corrections were those published in *Engineering* on February 5, 1904.

LOG SHEET—TEST OF 500-KW CURTIS TURBINE.

Particulars of Test.		Ammeter Readings		Standard Voltmeter Readings.	Average Load During Test in Kw.		Total Units Used Throughout Test.			Average Units.	Total Water, Lbs.	Water per Kw-hour, Lbs.	Vacuum, Ins.	Steam pressure, Lbs.	Superheat, F.°.	Speed, R.P.M.
Load.	Duration.	Stnd.	Swb'd.		Stnd.	Swb'd.	Stnd.	Swb'd.	Wtmtr.							
¼	1½ hrs.	234	224.5	519	128.5	123.25	191.75	184.9	208.26	196	4,879	24.9	28.8	156	51	1,835
½	1½ hrs.	460.7	453.65	547	252	248.12	378	372.2	not	375	8,400	22.64	28.6	155	50	1,820
¾	1½ hrs.	718.5	717.8	548	393.7	393.9	590.5	590.8	con'ctd	590.65	12,377	20.95	27.8	153	70	1,822
Full	1½ hrs.	922.5	921.4	555	512	511.4	768	767	760	764	15,755	20.6	26.9	153	104	1,820
1¼	54 min.	1244	1235	495	615.8	611.3	554.2	550.17	544	552	11,530	21	26.2	151	124	1,800

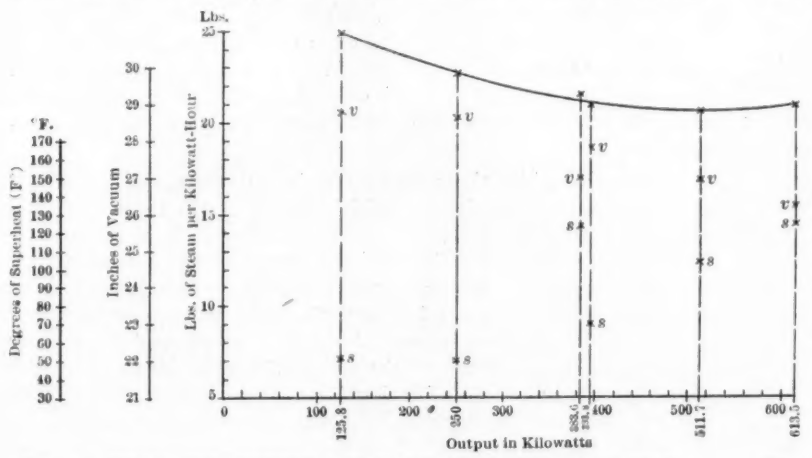


FIG. 1.—STEAM CONSUMPTION CURVE PLOTTED FROM ACTUAL READINGS, BAROMETER 30.16 IN.

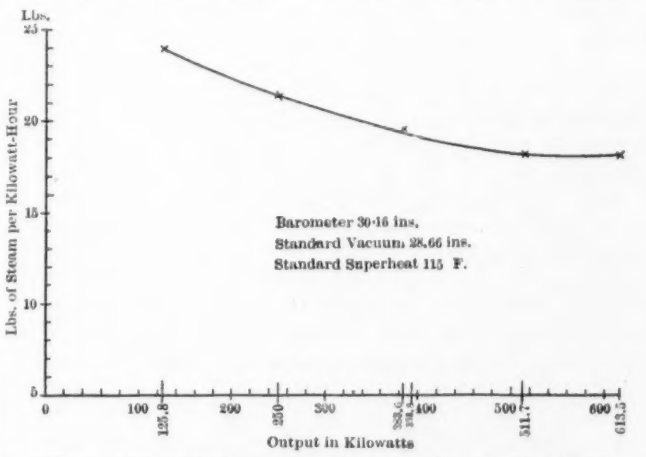


FIG. 2.—STEAM CONSUMPTION CURVE CORRECTED TO VACUUM AND SUPERHEAT.

Large Power Development in Mexico.

One of the most extensive power transmission systems in the world is now being hastened to completion in Mexico. The project is that of the Mexican Light & Power Company, Limited, a concern backed by Canadian capital, supplied from some of the sources which built the Sao Paulo (Brazil) Tramway, Light & Power Company, Limited; the Havana (Cuba) Electric Railway Company, and the Demerara (British West Indies) Electric Company, Limited. Mr. James Ross, of Montreal, is president of the company; Mr. F. S. Pearson, consulting engineer; Mr. Hugh L. Cooper, chief engineer, and Mr. M. T. Thompson is general superintendent of construction.

The company will utilize the power of the Necaxa and Tenango Rivers in the Province of Huauchinango, and transmit the current thus obtained to Mexico City and the El Oro mining district, which will mean that the initial transmission line will aggregate some 140 miles in length. The City of Mexico is situated on a plateau above sea level, between 7,000 and 8,000 ft. This tableland occupies substantially the whole of the southern central portion of the Republic of Mexico, and is surrounded by hills and mountains of considerable altitude. The descent from the plateau to the sea level is quite abrupt on all sides and while there are comparatively few rivers of much magnitude flowing from this elevation to the ocean some of those which find their way down the precipitous slopes of the sides of this great tableland possess magnificent possibilities in the way of hydraulic development.

The Mexican company is at present operating a large steam-driven station (formerly the Siemens-Halske plant) with a capacity of about 6,000 hp, in Mexico City. The cost of operation being high on account of local conditions—coal selling at upward of $20 a ton—and the possibility of largely increased demands for current being assured, it is the purpose of the company not only to substitute the power derived from Necaxa, but also to extend its lines into the mining districts to the north and east of Mexico, as well as into the agricultural sections lying about Apizaco, Irapuato and other adjacent territories. By the completion of the power plants upward of 80,000 hp will be generated.

The development of the Necaxa power is particularly interesting owing to the fact that the sites of the dams and power houses are among the mountains, at the edge of the great plateau, in an almost undeveloped country and more than 100 miles from any base of supplies. It has been necessary to build about sixty miles of road over the plain and through the mountains, of which a length of some thirty miles constituted, in itself, a problem involving very difficult and expensive engineering features. The locations selected for the storage basin, dams and power houses are in the valley of the Necaxa River, not far from Huauchinango, the principal town in the district of the same name and distant from the Mexican capital about 100 miles. At a point in the valley of the Necaxa—just where the river breaks through the mountain range bordering the plateau, to plunge downward on its way to the sea in a series of tremendous falls and turbulent rapids—there is being constructed a huge dam of earth, with concrete core, to be 140 ft. in height and nearly one-eighth of a mile in length across the top. The configuration of the valley through which the river flows for some three or four miles before reaching the site of the dam, is such as to allow the impounding of an enormous volume of water. The valley is rather broad and bounded on both sides by towering ranges and abrupt slopes.

In carrying out its extensive arrangements for the impounding of this water the company has been obliged to buy up three towns—Patoltecoyo, San Miguel and Necaxa—which have existed in this valley for generations and the sites of which will shortly be submerged under a great artificial lake not less than 125 ft. in depth. Even now practically all the inhabitants have removed their effects and have either departed altogether from the valley or have made new homes on the high lands not far distant from the site of the dam. The huge quantity of water that will be impounded in this great basin at high water mark will be nearly 40,000,000 cubic meters.

Running approximately parallel with the Necaxa River in the next valley to the south is the Tenango, substantially similar. The Tenango in the upper part of its course is somewhat more elevated than its neighbor and advantage is taken of this fact to deflect the entire volume of water passing through the upper course of the Tenango into the Nacaxa; this entailed the driving of a tunnel (No. 1) some 400 ft. in length. The Tenango having been dammed at a point just below the union of its two principal branches, the Rio Cocuila and the Rio Matzontla, an open cut of some 25 ft. has been run into the ridge lying between the Tenango and the Necaxa, and from a suitable tunnel face at the end of this cut an arched tunnel about a foot wide on the floor and 80 in. high to the top of the arch, has been driven into the mountain, meeting the Necaxa about the main dam.

The location of the main impounding dam is a most advantageous one. The surrounding mountains, at the point selected for the dam, verge closely together and extend rocky spurs toward each other in such a manner as to inclose the valley by a natural barrier. The great dam will shortly unite these spurs and close the natural outlet of the Necaxa River. Through one of these rocky spurs a tunnel has been driven in which are laid the steel tubes that conduct the water to the turbines situated almost 1,500 ft. below in a chasm near the foot of the second fall and some 500 ft. distant from the site of the dam. Here will be located generating plant No. 1 with six Escher-Wyss turbines, each having a rated capacity of 7,000 hp and direct-connected to Siemens-Halske generators. The discharge from the turbines will, in the future, be gathered behind a small dam some 100 ft. down the river from the power house and thence will be conducted through another tunnel about 1,000 ft. in length to a second power house (generating plant No. 2) farther down the valley, where 45,000 hp additional equipment will be installed. The fall of water on the second set of turbines will be approximately 120 ft.

The generators in all the power stations will operate at 300 r.p.m. and are to deliver 50-cycle, three-phase current to step-up transformers at 4,000 volts. The transformers, in turn, will deliver current to the line at 60,000 volts maximum. The General Electric Company secured the contract for the transformers. There will be 15 step-up machines of 2,000 kw capacity each and 16 step-down transformers of 1,800 kw. The same manufacturers also obtained the orders for the complete switchboards for the generating station at Necaxa and the distributing station in Mexico City.

It is the present intention to run two and possibly three independent trunk lines to Mexico City, each with a capacity of 20,000 hp—the desire of the company being to so far insure the reliability of its service that if any accident happens to one line another will always be in reserve. The conductors supported by steel towers erected about 450 ft. apart, will be run on Thomas porcelain insulators, which have been specially designed for the purpose, and which are among the largest ever used for a power transmission system.

The steel tubes to lead water from the main storage basin to the power house are two in number and for the first 100 ft. or so are 8 ft. in diameter. Thence for some 200 ft. they are 6 ft. in diameter, and at the end of this second section both tubes unite in a header, from which six 36-in. tubes, three in each of two tunnels, convey the water some 200 ft. down to the turbines. The course of the river below the main dam is tortuous and as the tubes are laid substantially in a straight line, it has been necessary to carry them over the river on masonry piers, through open cuts in small ridges and in several short tunnels through the larger ridges and spurs. The tubes in the first section are 3/8 of an inch steel and in the final section they are 29/32 of an inch.

About 2,500 workmen have been employed in building the new road, driving the tunnels, erecting the dam and preparing foundations for the power house. The installation of the first power plant involves the transportation of some 35,000 tons of machinery, cement and other construction material over the new road alluded to elsewhere, and has been built from Santiago on the Hidalgo Railroad, into Necaxa. For moving this vast amount of material two traction trains are in constant operation, besides a number of mule teams and pack animals.

Some of the falls of the Necaxa and Tenango, which will shortly be deprived of their present beauty and grandeur, are among the most remarkable in the world. Two of those on the Necaxa River drop vertically 360 and 710 ft., respectively. There are also two falls on the Tenango River quite close to each other that, with the intervening rapids, fall about 2,200 ft. When it is remembered that Niagara Falls have a drop of only about 165 ft. in the highest part, the magnificence of the great Necaxa Falls can be better appreciated.

The uses to which the currents will be put are varied. There is at present an opportunity for utilizing from 20,000 to 30,000 hp in the City of Mexico for driving cotton mills, flax mills, manufactories of different kinds, the city's lighting system and the extensive electric street railway. In the surrounding country are located many large mining properties, and several thousand horse-power will find a good market in these camps. Another large demand will be for pumping purposes. Much of the soil of the great Mexican plateau is fertile and capable of bearing large crops, provided it can be properly watered. At present irrigation is usually accomplished by the most crude and laborious methods, and is not undertaken on anything like a large scale.

Again, electricity will displace hand labor in the making of tortillas and centrally located, motor-driven mills, already in operation to some small extent, will grind the cereal for the masses of the people. The Necaxa power can be produced and brought into the City of Mexico at such cost as to enable the current to be sold at a very low rate. This will attract various manufacturers. There is little doubt that the entire capacity of the two great stations will be taken up shortly after service begins, and that through the enterprise and foresight of a few energetic men another source of natural power hitherto neglected will be contributing daily to the advancement of the Mexican people.

The Mexican Light & Power Company expects to have the Necaxa plant in full operation by next spring. Ere completion the company's undertaking is estimated to involve an expenditure of upward of $10,000,000 gold.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Standard railroad shares and various specialties were strong, but prices were somewhat irregular, due to large profit-taking transactions. The advance in the United States Steel issues was checked by realizing and uncertainty about the steel rail pool as to prices and allotments for the coming year. Bonds were strong, and a demand, apparently in anticipation of January reinvestments, is noted for high-grade dividend-paying stocks. Industrial stocks, although in increased favor, felt the influence of the recession in Steel shares, despite the continuance of bullish manipulation in Amalgamated Copper. In the traction group the principal event was the declaration of a 3 per cent. dividend upon Interborough Subway stock, making 5 per cent. for the year, which payment, it is construed, is from the surplus earnings of the Manhattan over the 7 per cent. guaranteed dividends on that stock, the strength of Interborough, as well as that of Brooklyn Rapid Transit, being the result of this favorable development in the traction situation. Electric securities were rather irregular, and there being absence of any general influence the individual stocks worked along independent lines. In the traction list Brooklyn Rapid Transit is practically unchanged as to price, although there was a good business done, the closing quotation being 68. Metropolitan Street Railway gained ⅞ point in closing at 124¼, there being brisk trading, 127,400 shares having been sold. Interborough Rapid Transit on the other hand lost 1¼ points of the gain recorded last week, closing at 167½. Both issues of Allis-Chalmers are down 1 point net, each, the closing prices being 19 for the common, and 70 for the preferred. General Electric was also a loser, closing at 191¼—a net loss of 1⅝ points. Westinghouse common is 3 points higher, the closing quotation being 184. Preferred closed at 197, a net loss of 1 point. Western Union is a fraction higher, the last price being 92⅞, and American Telephone & Telegraph made a net gain of 2½ points, closing at 148. The curb market was generally firm throughout the week and some issues made greater progress than prices on the Stock Exchange. Following are the closing quotations of December 6:

NEW YORK

	Nov. 29	Dec.		Nov. 29	Dec.
Allis-Chalmers Co.	19	18	Electric Vehicle	16	16
Allis-Chalmers Co. pfd.	68⅛	69	Electric Vehicle pfd.	24	28
American Tel. & Cable.	90	91	General Electric.	190	188
American Tel. & Tel.	148	148	Hudson River Tel.	..	..
American Dist. Tel.	..	..	Interborough Rap. Tran.	165⅛	168
Brooklyn Rapid Transit.	68⅛	68⅛	Metropolitan St. Ry.	124	123
Commercial Cable.	..	..	N. Y. & N. J Tel.	161	..
Electric Boat	40	40	Marconi Tel.	..	..
Electric Boat pfd.	67	68	Western Union Tel.	..	91½
Electric Lead Reduction.	⅛	⅛	Westinghouse com.	..	182
			Westinghouse pfd	..	194

BOSTON

	Nov. 29	Dec. 6		Nov. 29	Dec. 6
American Tel. & Tel.	148⅛	147	Western Tel. & Tel. pfd.	99⅛	*101
Cumberland Telephone.	118¾	122	Mexican Telephone.	2⅛	2
Edison Elec. Illum.	251	251	New England Telephone.	139¼	*140
General Electric.	189½	187	Mass. Elec. Ry.	15⅛	14⅝
Western Tel. & Tel.	21⅛	21	Mass. Elec Ry. pfd.	62	62⅛

PHILADELPHIA.

	Nov. 29	Dec. 6		Nov. 29	Dec.
American Railways.	49⅛	48⅛	Phila. Traction.	98	98¼
Elec. Storage Battery.	81	81	Phila. Electric.	8⅛	10⅛
Elec. Storage Battery pfd.	81	..	Phila. Rapid Trans.	17¾	18
Elec. Co. of America.	10⅛	10¼			

CHICAGO

	Nov. 29	Dec. 6		Nov. 29	Dec⅛
Central Union Tel.	..	..	National Carbon pfd.	100½	100
Chicago Edison.	..	172	Metropolitan Elev. com.	24¼	24
Chicago City Ry.	..	183	Union Traction.	12	12
Chicago Tel. Co.	..	142	Union Traction pfd.	46	42
National Carbon.	45¼	44			

* Asked.

ST. LOUIS TROLLEY BONDS.—F. S. Smithers & Co. and Spencer Trask & Co. are offering a block of the general first mortgage 4 per cent. bonds of the United Railways Company, of St. Louis. President Murray Carleton writes to the bankers as follows: "The St. Louis Transit Company during 1902 and 1903 and the early part of 1904 expended large sums of money for betterments, construction and equipment, to prepare itself to carry effectively and economically the largely increased traffic incident to the Louisiana Purchase Exposition. The above important expenditures inure entirely to the benefit of the United Railways Company. I am, therefore, of the opinion, notwithstanding the increased service required of it, that the condition of the track and equipment is good. The company's power plants have been fully maintained, and a detailed report now being prepared will, I think, show that no important additions need to be made to these plants for several years to come. I believe also that the company can maintain its track and equipment out of earnings for several years to come with little, if any, recourse to capital expenditure. The balance sheet of November 1, 1904, shows a surplus over all current and accrued liabilities of $633,259.66, $288,714.47 of which is represented by material and supplies on hand, leaving an actual cash surplus of $344,545.19; in addition to which the company has $7,000,000 of its preferred stock in the hands of trustees for future betterments and improvements." The following figures are for the year 1904 (two months estimated) and an official estimate for 1905:

	1904.	1905.
Gross earnings	$9,810,150	$8,334,872
Expenses and taxes	5,591,785	4,750.877
	$4,218,365	$3,583,995
Interest	1,886,080	1,886,080
Surplus	$2,332,285	$1,697,915

LONG ISLAND LIGHTING FRANCHISES.—The South Shore Traction Company, incorporated under the laws of New York with a capital stock of $2,000,000 (bond issue of $3,000,000 under application) and which has recently been granted a certificate of necessity of route by the Board of Railroad Commissioners for the building and operation of an electric railway to run in an easterly direction from the Greater New York line to some 30 villages in the County of Nassau and part of the County of Suffolk, Long Island, a distance of some 50 miles, has acquired all the stock of two electric lighting companies covering between 25 and 30 miles of territory along the eastern end of the route, in the towns of Brookhaven and Islip. By operating the lighting properties, together with the railway, it will be possible to serve many residents in the smaller vilages, or between the villages, who cannot secure light under existing circumstances. A main power house with substations will be constructed. The capacity of the plant will be about 3,000 kw. Construction will be begun either late this fall or early next spring. Mr. George E. Fisher, of 15 William Street, is president of the South Shore Company, while Mr. James F. Heyward, same address, formerly general manager of the City & Suburban Railway of Baltimore, is general manager and treasurer.

PORTCHESTER THIRD-RAIL ROAD.—It is stated that a strong syndicate, headed by Charles W. Morse and backing a construction company of which John B. McDonald is president, has taken up the New York and Portchester railway enterprise and will appeal direct to the Legislature at the coming session to get the franchise put through which the Aldermen last spring denied to the Portchester Company. To this end the Portchester Railway Construction Company has been organized with $1,500,000 paid-up capital. It will take over all the property of the present company and will assume all of its indebtedness. Prominent in the new corporation, in addition to Messrs Morse and McDonald, are: John W. Gates, Dave H. Morris, Samuel Untermyer, Henry F. Schoemaker, president of the Cincinnati, Hamilton and Dayton Road; George R. Sheldon, J. H. Harding, of Charles D. Barney & Co.; Harry S. Black, of the United States Realty Company, and others.

THE CALIFORNIA GAS & ELECTRIC CORPORATION has issued the following comparative statement of earnings for October:

	1903.	1904
Gross earnings	$244,279.09	$378,401.75
Operating expenses, taxes, etc.	179,625.44	283,622.62
Profit	64,653.65	94,779.13
Corp. bond interest	33,333.33	36,458.33
Balance	31,320.32	58,320.80
Sinking fund	12,500.00	12,500.00
Net surplus	18,820.32	45,820.80

The comparative statement of earnings and expenses for the eight months ending October 31, is:

	1903.	1904
Gross earnings	$1,811,577.17	$2,692,132.03
Operating expenses, taxes, etc.	1,712,114.60	2,015,273.86
Profit	499,462.57	676,858.17

NEW YORK CONSOLIDATED GAS.—The report is that the Consolidated Gas Company of New York will issue an additional $50,000,000 of stock to provide for the capital expenditures in connection with the building of the Astoria gas plant. The issue of this new stock will, it is said, give valuable rights to the stockholders. In June the company issued $20,000,000 6 per cent. convertible debentures.

DIVIDENDS.—The Chicago Railway directors have declared the regular quarterly dividend of 2¼ per cent., payable. A dividend of 1½ per cent. for the quarter ending December 31, this year has been declared by the Interborough Rapid Transit Company to

holders of Manhattan Elevated Railway stock. An additional dividend of three-quarters of 1 per cent. was declared on the same stock, for the three quarters ending at the same time. This makes a dividend of 1¾ on each of the last three quarters of this year, or payment at the rate of 7 per cent. per annum. The lease of the Manhattan properties by the Interborough Company provided that for the first three years of the lease the stock should receive an annual rental of 6 per cent., with an extra 1 per cent. if the earnings of the road should warrant it. This the Interborough has paid, since the lease of the property.

FEDERAL TELEPHONE EARNINGS.—The statement of earnings of subsidiary companies of the Federal Telephone Company, including eight companies for October and the United States Company for September, shows an increase of 14.9 per cent. in gross and an increase of 21 per cent. in net, combined earnings, as compared to the corresponding months of last year. The statement of the Cuyahoga company is particularly good, showing an increase of 21.4 per cent. in gross and an increase of 26.4 per cent. in net. The United States Company for September shows an increase of 7.5 per cent. in gross, but there was also a substantial increase in operating expenses, owing to the fact that unusually large charges are being made at this season of the year for maintenance of way and equipment, and the increase was nearly all wiped out in the net showing. The company is doing all the improvement work that can be done before cold weather sets in, and for this reason the net results will not show up so well until winter, when the extraordinary charges will be reduced. The detailed statement shows as follows for all the companies:

	1904.	1903.
Gross earnings	$94,789.64	$82,189.71
Net earnings	35,846.80	29,630.18
Gross increase	14.9 per cent.	
Net increase	21.0 per cent.	

THE BOSTON ELEVATED RAILROAD COMPANY has issued its report for the year ended September 30, 1904. The income account compares as follows:

	1904.	1903.	1902.	1901.
Gross	$12,391,353	$11,959,514	$11,321,030	$10,792,993
Expenses	8,631,553	8,259,860	7,862,571	7,336,597
Net	$3,759,800	$3,699,654	$3,458,458	$3,456,396
Other increase	45,240	59,856	.....	76,503
Total increase	$3,805,040	$3,759,510	$3,458,458	$3,532,899
Charges	2,975,268	2,932,556	2,836,560	2,896,359
Surplus	$829,772	$826,954	$621,898	$836,540
Dividends	798,000	798,000	600,000	575,000
Surplus	$31,772	$28,954	$21,898	$61,540

Passenger traffic statistics compare as follows:

Rev. miles	48,317,881	47,476,702	45,772,836	43,631,384
Rev. pass.	241,681,945	233,563,578	222,484,811	213,107,600

The charges of $2,975,268 are made up of the following items:

Interest	$629,600
Taxes	925,418
Rentals	1,223,043
Subway rental	197,206
Total	$2,975,268

Single surface trackage operated, 423,211 miles; elevated, 16,015 miles. Total addition to property during the year, $2,802,387. The cost of removal of ice and snow was $284,476. Damages paid for injuries were $563,013. Legal expenses were $254,833. Wages paid were $3,912,151.

Commercial Intelligence.

THE WEEK IN TRADE.—Favorable developments are reported in the main. Cooler weather has helped retail trade; stimulated re-orders from jobbers, and improved collections, except in some parts of the South where holding of cotton is reported. Holiday business is heavy, and traffic congestion at several points indicates that the growth of business has overtaxed railroad facilities. Earnings of all roads reporting for November show an average gain of 7.1 per cent. over last year. A record-breaking yield of cotton is bringing the price nearer the point at which normal consumption may be resumed, although there is still much idle machinery at Fall River. Other manufacturing news is gratifying, especially regarding the leading lines. Structural work increases and car shops are crowded with orders, while many idle steel mills have resumed. In iron, steel, coal, lumber and kindred lines, there is an optimistic feeling, the only drawbacks noted being that manufacturers are confronted with prospective higher cost of production. Finished lines of iron and steel note most activity, and conflicting reports of further advances come from various points. The other metals, notably copper, lead and tin, are strong. Lake copper is quoted at 14⅞ to 15⅛c; electrolytic, 14¾ to 15c; and casting stock, 14½ to 14¾c. Failures in November were fewer in number and liabilities the lightest in any month but one in 1904. The number reported by *Bradstreet's* for the week ending December 1 was 184, against 193 the week previous, and 239 the corresponding week last year.

LOCKPORT NIAGARA POWER.—The Buffalo *News* says: The Niagara, Lockport & Ontario Power Company will put through its project to build a hydraulic canal and big electric power plant and William K. Vanderbilt will furnish the money to do it. Weeks ago the *News* contained the exclusive announcement that the New York Central Railroad had contracted for the entire output of the Ontario Power Company, in which J. J. Albright and General Edmund Hayes are largely interested. At the same time it was stated that the Central people were behind the Lockport power project, but, as they wished to use electric power before it could be produced by the Lockport Company, a contract had been entered into with the Hayes-Albright concern, the Central intending eventually to use the output of both plants. In general the plan of the proposed power plant is as follows: Beginning at a point on the Niagara River somewhere between North Tonawanda and La Salle, a large canal will run as nearly on a direct line as possible to the city of Lockport, a distance of 10 or 11 miles. The power house with its wheel pits will be located within one-half mile of the beginning of the gorge in the city of Lockport at the New York Central tracks. The precise location of the outlet of the tunnel through which the water will escape from the wheel pit has not been determined, but if the property owners along Eighteen-mile Creek are willing, the water will be discharged into the gorge and will flow through the creek into Lake Ontario. If there is too much opposition from the owners of the uplands then the water will be conducted into the lake by some other route. Precise information as to the size of the canal and details regarding the power house can be obtained only from the engineer of the company, who is in New York City, but in general it may be stated that the capacity of the plant will be 200,000 horsepower. The initial output will be 100,000 horsepower and will be raised to the maximum as needed.

THE CANADIAN WESTINGHOUSE COMPANY, LTD., has sold to the Hamilton Cataract, Power, Light & Traction Company for use in its Victoria sub-station at Hamilton, Ont., two motor-generator sets, each consisting of a synchronous motor and a direct-current generator. The motor-generator sets will be of the two-bearing type, the generators delivering direct current at 550 volts to the railway system, and each being rated at 750 kw. The synchronous motors will take two-phase current at 8,000 alternations and 2,400 volts, and will be rated at 1,380 horsepower. The excess of capacity in the motors is provided so that they may be used for raising the power factor of the transmission system. Power is taken through lowering transformers from the high-tension transmission line from the De Cew Falls station of the company. These motor-generator sets will be built at the Westinghouse Works at East Pittsburg, Pa.

THE POWER SPECIALTY COMPANY, 126 Liberty Street, New York City, manufacturer of the well-known Foster superheater, has recently closed the following contracts: Chicago & Western Indiana Railroad, 1,800 hp of superheaters; Armour & Company, Chicago, 5 separately fired; Cincinnati Water Works, 1,600 hp; Hammond Glue Company, Chicago, 50 hp; West Coast Company, Chicago, 100 hp; Chicago City Electric Light Plant, 1,200 hp; Baltimore Copper Smelting & Rolling Company, 680 hp; Chihuahua & Pacific Railway, 100 hp; Tennessee Copper Company, 1,000 hp; Dominion Bridge Company, Montreal, 750 hp.

EQUIPMENT FOR LITHOGRAPHIC WORKS.—The Snyder & Black Lithographic Company's building, at Frankfort and William Streets, New York, is to have an electric power plant equipped with a 225-hp and a 75-hp Harrisburg-Fleming side crank engine, arranged for direct connection to 150-kw and 40-kw generators respectively. The contracts for the generators, as well as for several motors, have not been let. Milliken Brothers, Bowling Green Building, who are the contractors for the building, are ordering the equipment for power.

CONTRACT FOR BELFAST TROLLEYS.—A cable dispatch from London of December 2 says: "J. G. White & Co., of London and New York, have received from the corporation of Belfast the contract for the electrification of the Belfast street railways. The firm's bid was about $2,500,000." The details of this have already been referred to in these columns.

NEW YORK PIPE GALLERIES.—The New York Board of Estimate has voted favoring the construction of pipe galleries in the Subway. Corporation Counsel Delany has rendered an opinion saying that Water Commissioner Oakley has the power to go ahead with this work. When ex-Borough President Cantor tried to build pipe galleries the courts enjoined him, holding that the power did not rest with his office. The matter came before the Board of Estimate last week, on the application of Commissioner Oakley for an appropriation of $450,000 to construct pipe galleries along the lower Broadway and Fulton Street extension of the Subway. Although

the board was in favor of going ahead with this work, it was decided to refer the application for money back to Commissioner Oakley until after the first of the year. By that time the Controller will have his report ready on the amount of money available for public improvements.

NEW YORK CITY LIGHTING is again an agitated theme. The authorities having decided to pay bills whose settlement has been withheld two years, an injunction has been secured by W. R. Hearst to stop such honest and decent settlement. The total sum of money due to the gas and electrical companies, according to their own bills, for lighting the streets of the Greater City from January, 1903, to November, 1904, is $4,229,465, of which about $2,500,000 was for electricity and $1,700,000 for gas. When, in Mayor Low's administration, the companies were offered contracts at 60 per cent., or $1,500,000, of their bids for electrical lighting and 80 per cent., or $1,360,000, on the gas bids—a total reduction of about $1,350,000—all the twenty-six companies having contracts with the city refused to accept the offer with the exception of one company in Brooklyn and one in Queens. These two companies accepted the city's offer—amounts not stated—for the reason, as was stated at the time, that they could not afford to have the money due to them tied up for an indefinite period. Comptroller Grout has agreed to pay the face values of the claims of the other companies, but only on the agreement that the companies shall forego the interest, amounting to $245,000, which had piled up while the city refused to pay the bills. The compromise, which has apparently cost the city about $1,000,000, or a little more above its original offer, is, he thinks, a good one. Meantime, as another drive at the lighting interests, a bill has been prepared for a municipal plant to do city lighting, although one or two members of the Board of Estimate want to go further, with a plant to supply everybody.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, is building a three-story addition to its factory, which will add 50,000 sq. ft. of floor space to the plant. The construction is of the slow-burning type, and it is expected that the addition will be ready for occupancy about the first of the year. The cost will be about $50,000. The building will be equipped with the Grenelle system of sprinklers, will be heated by the Paul system and lighted with mercury vapor lamps. The fire storage tank, with a capacity of 75,000 gallons, will be located under the boiler room, and the fire pump will have a capacity of 750 gallons a minute. The power plant for the entire factory will be in the new building and will be up-to-date in every respect. As soon as this building is completed work will be begun on an addition to the present office building, to which another story will be added. The third floor of this building will be entirely devoted to the engineering department, while the superintendent, chief of the engineering department, cost department, publicity department and a part of the accounting department will occupy the second floor. The executive offices and the rest of the accounting department will be on the first floor as at present. The works of the Cutler-Hammer Manufacturing Company now occupy an entire block, with the exception of a small plot on one corner. Recently this company purchased a plot of ground on St. Paul Avenue, opposite its factory, upon part of which a brass foundry has been erected. Upon the remainder of this property buildings will be erected the coming year for storage and factory purposes.

ADVANCE IN RUBBER.—The recent advance in prices of and demand for India rubber lends especial interest to some figures just prepared by the Department of Commerce and Labor through its Bureau of Statistics, which show the quantity and value of rubber imported into the United States during the current year and in a term of earlier years. These figures show that in both quantity and value the imports of the year about to end will probably exceed those of any earlier year. The largest importation in any complete fiscal year is 55¼ million pounds in the fiscal year 1901, and the highest value in any earlier year is $31,707,630 in 1899. In the calendar year about to end, however, the indications are that the quantity imported will reach 600 million pounds and the value more than 40 million dollars. In the ten months ending with October the quantity of crude rubber imported is practically 50 million pounds, or, to be exact, 49,951,326 pounds, and the value was $34,315,180. In the latest month for which figures are available, October, the quantity imported was 5,397,981 pounds, and the value $3,450,840; so that if the figures of October are an index to the prospective figures for November and December, it seems likely that the total quantity of India rubber imported during the calendar year will reach 60 million pounds, and the value exceed 40 million dollars.

JAPAN'S MACHINERY DEMANDS.—In October last Japan took 10 locomotives and 3,075 tons of steel rails from the United States. It took over 100 per cent. more electrical machinery than in October, 1903, and increased its imports of steel and manufactures of steel ordered from this country. The war between Japan and Russia has had the effect of more than trebling American exports of electrical machinery to Japan. In the ten months ending October last Japan took $899,199 of American electrical machinery as against $251,168 for the ten months ending October, 1903. The following table shows the principal items of export trade with Japan for October and ten months ending October:

	October.	10 mos. '04.	10 mos. '03.
Electrical machinery	$66,754	$899,199	$251,168
Typewriters	626	14,585	17,860
Builders' hardware	14,425	138,134	106,668
Steel rails	116,580	797,269	.....
Sewing machines	6,807	40,841	40,356

A LONG ELEVATED ROAD.—An application has been filed at the State House for permission to construct an elevated electric railway from Boston to Worcester, Mass. This, it is asserted, is only the experimental part of a through line to New York ultimately, with branches elsewhere. Frank E. Hawkes, of the Boston Zinc Works; Dr. Charles C. Cutting, of Newtonville, and T. Green, of Boston, are the petitioners. The petition sets forth that the petitioners will erect an elevated railroad beginning at the Dudley Street terminal of the Boston Elevated Company's line and extending to Worcester. The exact plan of the line is not given, but it is said that it will be given later in a bill that the petitioners intend to have introduced in the Legislature.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, Chicago, is having a heavy demand for its new self-restoring drop switchboard, with the "never-failing" restoring device, and for its long-distance telephones. Among recent shipments were switchboard equipments for Urbana Telephone Company, Urbana, Ind.; Mankato Citizens' Telephone Company, Mankato, Minn.; Wilmot Mutual Telephone Company, Cromwell, Ind.; Hackeman & Schroder, Jacksonville, Fla.; Rush Hill Telephone Company, Rush Hill, Mo.; Union Telephone Company, Divernon, Ill.; South Wayne Telephone Company, South Wayne, Wis.; Summitville Telephone Company, Summitville, Ind.; and Jefferson County Telephone Company, Fort Atkinson, Wis.

AMERICAN ELECTRIC TELEPHONE COMPANY.—Contract has been let, and work commenced, upon the building of a new factory for the American Electric Telephone Company of Chicago. The new factory is to be situated at State and Sixty-fourth Streets. The property consists of a 12-acre tract, and the factory which is being erected will cost approximately $150,000. The building will be in readiness for occupancy May 1, 1905, at which date the American Company will move from its present location at 36-58 West Jackson Boulevard.

WESTINGHOUSE BIG MEXICAN CONTRACT.—The Westinghouse Electric & Manufacturing Company, through its agents, Messrs. G. & O. Braniff & Co., of Mexico, has been awarded the contract for electrical apparatus to be installed by the El Oro Mining & Railway Company, El Oro, Mexico. This contract amounts to nearly $100,000.

WESTINGHOUSE TURBINES FOR BALTIMORE.—The Eastern Electric Construction Company, of Baltimore, Md., which is to construct a power plant in that city involving an expenditure not far short of $2,000,000, has awarded a contract to the Westinghouse Company for two turbo-generating sets of 2,000 kw capacity each. The contract also calls for the necessary switchboards.

MOTORS FOR WATERVLIET ARSENAL.—The Crocker-Wheeler Company, through its New York offices, Mr. F. B. De Gress, manager, has taken a contract for thirty-four motors, to be installed in the new arsenal shops at Watervliet, N. Y. The motors will aggregate 340 hp. There will be fifteen machines 5 hp capacity each, seven of 10 hp, six of 15 hp, three of 20 hp, and three of 25 hp.

ALLIS-CHALMERS-BULLOCK EQUIPMENT.—The Robert Gair Company, Brooklyn, has placed a contract with the Allis-Chalmers Company for the electrical equipment to be installed in its new factory. The plant will include two 300-hp Reynolds Corliss engines, direct-connected to Bullock direct-current, 125-volt generators of 200 kw capacity each.

THE EDISON STORAGE BATTERY is to be manufactured in Germany under the auspices of the Bergmann Electrical Works, of which Mr. S. Bergmann is the head, at Berlin. Mr. Edison will be a member of the board of directors. Mr. Bergmann has recently been in this country in regard to the matter.

ALAMO MINES TO HAVE ELECTRICITY.—The Alamo Electric Power & Milling Company, of Alamo, Lower California, has decided to construct an electric power plant for the purpose of operating its gold mining property on an extensive scale.

ELEVATOR FOR CATHEDRAL.—The Otis Elevator Company has shipped from Yonkers this week an electric elevator for the Grand Cathedral at Berlin, for the exclusive use of the German Emperor.

CHICAGO POST-OFFICE.—Assistant Secretary of the Treasury Taylor has directed the publication of advertisements for proposals for furniture for the new Chicago Post-office. About $50,000 will be expended for lighting fixtures.

General News.

THE TELEPHONE.

CULLMAN, ALA.—Walter Cable has sold for $2000 his half interest in the Cullman Telephone system to S. L. Sherrill, of Hartselle, who owned the other half.

MONTGOMERY, ALA.—The Baldwin County Telephone Company has been granted an amendment to its charter permitting an increase of capital stock to $18,000.

SILOAM SPRINGS, ARK.—The Siloam Springs Telephone Company has been chartered with a capital stock of $50,000. Incorporators: Thos. Williams and W. T. Stahl.

KENNETT, CAL.—A private telephone line will be built by the Mammoth Company from Kennett to Redding.

SUISAN CITY, CAL.—Permission has been granted to the E. B. & A. L. Stone Company to construct a pole line for telephone wires from Suisan City along the country road to the rock quarries at Thomason.

SANTA CLARA, CAL.—The Sunset Telephon Company will overhaul its entire system. The most important change will be a large cable extending on Franklin St., from Jackson to the station, which will carry 150 wires.

CRIPPLE CREEK, COL.—The City Council has practically agreed to allow the El Paso Telephone Company a franchise to operate in this city.

MONMOUTH, ILL.—The Central Union Telephone Company will put in a new plant in this city.

STERLING, ILL.—The Deer Grove Mutual Telephone Company will install a line from Deer Grove to Hahnman.

AUBURN, ILL.—The Auburn Telephone Company has been formed with $35,000 capital. Incorporators: W. H. Ramsey, E. R. Conklin and F. W. Kelley.

BLUFFS, ILL.—The Farmers' Exchange Telephone Company has been incorporated with a capital of $10,000. Henry Knoepple, Geo. W. Vangundy and Henry Finnigsmeier are the incorporators.

DANVILLE, ILL.—The Eastern Illinois is to rebuild its telegraph system between Danville and Watseka, and Westville and Sidell. The work will commence as soon as the poles arrive and it will take almost a year to complete the job.

FREEPORT, ILL.—The Stephenson County Telephone Company has petitioned the City Council to amend the ordinance passed November 18, 1901, that granted the company the right to operate a system of telephones in Freeport during a period of 20 years, claiming that the rates now charged do not pay the running expenses of the telephones and it is impossible to secure a fair profit under the present schedules. An ordinance providing for a change in the rates was read and referred to the Council.

CHICAGO, ILL.—Mr. P. C. Burns has purchased for the use of the American Electric Telephone Company 800 by 1200 feet of ground at State and Sixty-sixth Streets. A manufacturing plant is to be erected on this land. A power plant also will be built, in which will be installed a complete equipment for furnishing power, heat and light to the building. Electricity will be the power utilized for machinery, which will be equipped with motors. The work will be started immediately and the building completed May 1, 1905. The cost of the completed building is estimated at $150,000. Plans for the building have been completed by Architects Nimmons and Fellows.

EVANSVILLE, IND.—The Cumberland Telephone Company has applied to the Board of Works for a 45-year franchise. The sum of $2225 a year is offered the city. The ordinance provides that the wires are to be underground.

KASSON, IA.—A mutual telephone company has been organized at Kasson.

ROCKWELL, IA.—The Iowa Telephone Company will build a line to Thornton.

CORNING, IA.—A telephone line is being constructed between this town and Carbon.

DES MOINES, IA.—The Kingsley Telephone Company has increased its capital stock to $15,000.

WATERLOO, IA.—F. W. Chapman has the contract to build the new line for the Iowa Telephone Company.

DUBUQUE, IA.—The Dubuque & Interstate Telephone companies announce the opening of a direct line from here to Freeport.

ELDON, IA.—The Eldon Telephone Company contemplates a number of improvements to its system, including considerable cable work.

WEBSTER CITY, IA.—C. L. Briggs has the contract for the building for the Martin Telephone Company. J. R. White is the architect.

ESTHERVILLE, IA.—A franchise has been granted a local telephone company which will enter into competition with the Western Electric Company.

FORT DODGE, IA.—The Fort Dodge Telephone Company has made contracts for connections with new telephone exchanges at Badger, Clare, Barnum and Mooreland.

WAVERLY, IA.—Bangs & Barrows have organized the Warren Township Rural Company. The company is officered as follows: A. Nolte, president; Wm. Wendt, vice-president; Emil Walther, secretary and treasurer.

RED OAK, IA.— The officers of the new Mutual Telephone Company, recently organized, are Frank S. Smith, president; Geo. Bass, vice-president; A. B. Steiner, secretary; Frank Lang, treasurer, and J. W. Crawford, manager.

KANSAS CITY, KAN.—The Bell Company is projecting a long distance line to Denver which will extend from this city to Beatrice, Neb., where it will connect with a line extending in a westerly direction from Omaha. From Beatrice a single line will run direct to Denver through the southern part of Nebraska.

VINNIE, KY.—The Vinnie Telephone Company has been formed, capital $1000. Incorporators: John Hill, B. H. McGahan and G. M. McKinley.

VALLEY STREAM, L. I.—The effort of the New York & New Jersey Telephone Company to erect telephone poles on each side of the Merrick road in Valley Stream is being met with much opposition and has resulted in condemnation proceedings brought by the company against the Royal Land Company of New York. The matter has been referred by Justice Marean to ex-County Judge Hurd as referee.

WILBRAHAM, MASS.—The petition of the New England Telephone & Telegraph Company to run a new line from the "Mill Tree" to the Hampden line, has been granted.

CITY OF MEXICO, MEX.—It is expected that the Mexican Government will soon act on the plans submitted some time ago by the Mexican Telephone Company for the installation of a central energy telephone system and the placing of its wires underground in the central portion of the City of Mexico. As soon as the necessary official authority is granted, the work will begin.

SAULT STE MARIE, MICH.—The Michigan State Telephone Company's service at the Soo is to be considerably improved next season.

MARSHALL, MICH.—The Citizens' Telephone Company of Grand Rapids has purchased the Foote Telephone Exchange of this city.

GRAND RAPIDS, MICH.—The Citizens' Telephone Company has purchased the exchange of the Luther Telephone Company. J. B. Prout will be retained as manager of the exchange.

BAY CITY, MICH.—Negotiations are on between the Valley Telephone Company, of this place and Saginaw and the Citizens Telephone Company, of Grand Rapids. Something in the nature of a union of the two companies is said to be involved. J. D. Ware is manager of the Grand Rapids Company.

LYNDALE, MINN.—A telephone line is to be run from Watertown to Lyndale.

WESTBROOK, MINN.—The Southwestern Minnesota Telephone Company seeks a franchise through here.

HUTCHINSON, MINN.—The Hutchinson Telephone Company will extend a line from this city to Lake Side.

ST. PAUL, MINN.—The Twin City Telephone Company has received permission to extend lines upon several streets.

INTERNATIONAL FALLS, MINN.—The Rainy River International Teleprone Company intends to install a telephone system here.

LITTLE FALLS, MINN.—Guy Cadwell will organize a rural telephone company and build a line from Mille Lacs lake to Pierz.

ZUMBRO FALLS, MINN.—The Zumbro Falls Farmers' Telephone Company has decided to extend its line to Bear Valley.

BIRD ISLAND, MINN.—This place is talking of an independent telephone line and exchange connection with the twin cities by building a line to Hector.

RICHWOOD, MINN.—A telephone line will be established during the coming year to Richwood, Callaway and the surrounding country.

LE SEUR, MINN.—The Farmers & Merchants' Mutual Telephone Company has just completed and opened a service line from this city to Belle Plaine.

DUBLIN, MINN.—The officers of the Murdock & Louriston Telephone Company have made arrangements to connect with the Tri-State Telephone Company.

ST. CLOUD, MINN.—A rural telephone line will be built from Luxemburg by P. J. Winter and others. A rural line is projected in Minden. Mayhew Lake also proposes a rural line.

BRAINERD, MINN.—C. A. Walker, owner of the Brainerd Telephone system, is trying to interest the people in regard to a telephone line from here to Walker, to take in Jenkins, Pine River and several other towns.

SHERIDAN, MONT.—The Rocky Mountain Bell Telephone Company is extending its lines in the Ruby Valley and improving the service.

MISSOULA, MONT.—With the completion of the new telephone building the Bell Company is to put in a complete rural system which will take in all of the country within a radius of 25 miles of Missoula.

ADAIR, MO.—A new telephone line is being built from this city to Sperry in Adair County.

KANSAS CITY, MO.—A long-distance line is being projected to Denver by the Bell Telephone Company.

HUMANSVILLE, MO.—Floyd J. McComb, of Lebanon, has bought the telephone exchange in this place.

MEXICO, MO.—The Mexico-Laddonia Telephone Company has asked for a franchise to establish an exchange here.

JOPLIN, MO.—The Western Independent Telephone Company will extend its line into this city in a short time.

ARGENTINE, MO.—Officials of the Home Telephone Company have accepted the franchise recently granted that company by the City Council of Argentine, and the erection of lines in that city will begin at once.

CRETE, NEB.—The City Council has granted the right to the Western Telephone Company to enter this city.

PERU, NEB.—The management of the Peru Telephone Company has changed hands, Mr. Abbott now having control.

PLATTE CENTER, NEB.—The Farmers' Independent Telephone Company has been incorporated with a capital of $10,000.

OMAHA, NEB.—The Nebraska Telephone Company will spend approximately $250,000 the coming year in improvements.

JANSEN, NEB.—The Jansen Telephone Company has been chartered. Capital $10,000. J. E. Grebe, John Mider and others are the incorporators.

LINCOLN, NEB.—The Bellwood Telephone Company, of Butler County, with an authorized capital stock of $7500, has been organized by A. A. Jones, J. P. Meinyer, C. Meister and W. H. Grant. Articles of incorporation have been filed.

PENN YAN, N. Y.—The Inter-Ocean Telephone & Telegraph Company is extending the line from this city to Watkins.

NEWVILLE, N. Y.—The Interstate Telephone Company is extending its line southward from here into the town of Stark.

TROY, N. Y.—The Council is taking steps requiring the Western Union Telegraph Company to place its wires underground.

OXFORD, N. Y.—At a meeting of the stockholders of the Oxford Valley Telephone Company, the capital stock was increased from $1000 to $5000.

LEONARDSVILLE, N. Y.—The Leonardsville Telephone Company has been incorporated; capital $1000. Directors: Eli S. Brand, Irving A. Crandall and others.

WILMINGTON, N. C.—The Bell Telephone Company has just completed a long distance line from Wilmington, N. C., to Mullins, S. C., giving Wilmington eight long distance circuits.

GREENSBORO, N. C.—The Board of Aldermen has adopted the underground wire ordinance after striking out the word telegraph, and as it now stands all telephone wires must be put underground in the business section.

MIDDLETOWN, OHIO.—Judge Jones has granted the Middletown Telephone Company the privilege of entering the town.

CINCINNATI, OHIO.—The new telephone exchange at Canal and Race Streets, to be known as "Canal," has been opened. The building cost $60,000, and is supplied with lounging rooms for employes and all conveniences. The switchboard cost about $100,000, and is similar to that in use in the main office. Its capacity is 9600 subscribers.

HENNESSEY, OKLA.—The Center Township Rural Telephone Company has been formed, capital $1000. Incorporators: Frank Hassler, of Dover; Ben Thorne, Wm. Beaman and others, of this city.

PHILADELPHIA, PA.—It is proposed to erect the telephone system along the Philadelphia and Easton trolley road at once.

NARRAGANSETT, R. I.—The Providence Telephone Company has been granted an exclusive franchise in this place.

GEORGETOWN, S. C.—The Georgetown & Camfield Telephone Company, in South Carolina, has been chartered with $500 capital.

EDGEMONT, S. D.—Hugh Houghton and others have built a telephone line from Hot Springs.

WOONSOCKET, S. D.—The rural telephone line between Woonsocket and Letcher is completed and in operation.

BRULE, S. D.—It is stated that W. W. Main, of Elk Point, has purchased the rights of the Ryan Telephone Company.

CHAMBERLAIN, S. D.—Frank B. Rowe has completed his line south from Chamberlain to Grandview township. He expects to extend branch lines into Ola.

MADISON, S. D.—The Orland Telephone Company will soon commence the construction of a telephone line to Madison. P. M. Venner is president of the company.

CHATTANOOGA, TENN.—The Citizens' Telephone Company, of Hamblen County, has amended its charter, increasing its capital stock to $18,000.

TEXARKANA, TEX.—The Phoenix Telephone Company will extend its long distance line to Sherman, Tex.

ALVIN, TEX.—The Alvin & Angleton Telephone Company will extend its line to Friendswood, in Galveston County.

CLARKSVILLE, TEX.—The Home Telephone Company, of Clarksville, has been chartered, capital $2500. Incorporators: John B. King, N. P. Doak and Hiram Glass.

DALLAS, TEX.—F. B. McElroy has petitioned the Council to allow him a long distance telephone franchise so that he may connect Dallas with the independent telephone companies of other cities.

CHASE CITY, VA.—A telephone line is being considered between this place and Red Oak, in Charlotte County.

BRIDGEPORT, W. VA.—At a meeting of the stockholders of the Belmont Telephone Company at Bridgeport it was decided to double the capital stock. The present capital stock is $75,000.

MILWAUKEE, WIS.—The Lone Rock Telephone Company has been incorporated with a capital stock of $1500. The incorporators are Andrew Harter, George Jamieson and H. Brace.

WHITE OAK SPRINGS, WIS.—The White Oak Telephone Company has been chartered, capital $25,000. Incorporators: H. A. Beckwith, Jos. Edge and Mrs. S. J. Coulthard.

EAU CLAIRE, WIS.—The Chippewa County Telephone Company will make two new extensions. Work on the extension of the line to Cobban, Cornell, Flambeau and Holcomb is now in progress.

MILWAUKEE, WIS.—The Independent Consolidated Telephone Company has been chartered, capital $500,000, by A. L. Hutchinson, Edw. I. Fairchild and others. The company will operate telephone lines anywhere in Wisconsin.

ANSON, WIS.—A meeting of the farmers of the town of Anson has been held for the purpose of listening to a proposition from the Bell Telephone Company relative to the extension of the Bell system out in that town. The Anson Telephone Company has been formed and will build a plant at once.

OTTAWA, ONT.—Steps are being taken to establish a rural telephone system in the county of Waterloo, Ont., and a company with that object in view is being organized. The system will probably be operated by the municipality.

ELECTRIC LIGHT AND POWER.

POCAHONTAS, ARK.—The City Council has awarded to S. C. Dowell, of Walnut Ridge, a franchise for an electric light plant.

SEARCY, ARK.—The contract has been awarded to the Black Hawk Electric Company, of Davenport, Ia., for the erection of an electric light plant.

SAN FRANCISCO, CAL.—The Loon Lake Water & Power Company has been formed by S. Forbes, C. Forbes, W. Gregory and others. Capital, $200,000.

ATLANTA, GA.—The Peachtree Lighting Company, of Atlanta, has applied for a charter for the purpose of supplying lights on the Peachtree road. The capital is $600 to $5000. Arnold Broyles is interested.

SAN FRANCISCO, CAL.—The United Railroads will abandon its power stations in San Francisco as soon as possible, but will retain its sub-stations where the current is reduced from 13,000 volts and straightened out. The California Gas & Electric Corporation has not definitely decided where the large gas works and gas engine power plant are to be located, but may possibly utilize the United Railroads' North Beach power station as a portion of the new plant.

LAFAYETTE, COL.—The Lafayette-Louisville Electric Company, which has been operating in both towns about nine years, and has been negotiating with the Consumers' Electric Company, organized about five months since, has sold its business to the latter for a consideration of $14,000. The consolidation was due to close competition which compelled the Lafayette-Louisville Electric Company to cut its rates 50 per cent. in Louisville.

GLASTONBURY, CONN.—The J. B. Williams Company is making some important improvements in its factory. The company will use electricity as a motive power largely in the future and a large generator has been located in the power house which will furnish electric power for the factory.

WILMINGTON, DEL.—A petition has been circulated in Wilmington for presentation to the Legislature, in behalf of the bill chartering an electric power company, which wants a franchise permitting it to utilize the waters of the Deerfield River and its tributaries, by erecting a series of dams with a big plant below Readsboro. The promoters of the enterprise are R. C. Corson, George W. Plumb, Faxon Bowen and others. The water power contemplated to be utilized is a large one. The company is capitalized at $200,000.

ATLANTA, GA.—The Atlanta Water & Electric Power Company's plant, which utilizes the flow of Bull Sluice Shoals, near Atlanta, Ga., is now furnishing power to the Georgia Railway & Electric Company for operating street railways for lighting and for power purposes.

EFFINGHAM, ILL.—The Effingham Electric Light & Power Company's franchises having expired in November, the City Council will, at a meeting in December, take up the question of granting another franchise for 15 years or putting in a municipal plant.

CHRISNEY, IND.—The Chrisney Electric Light Company has filed articles of incorporation with the Secretary of State. The capital stock is $15,000. The purpose of the company is to install and operate a plant to furnish and supply electric lights for the town and the citizens. The incorporators are J. C. Fella, B. N. Fisher, J. B. Chrisney, Gus Billart and others.

CRAWFORDSVILLE, IND.—The farmers of Montgomery and Boone counties along the line of the Northwestern Traction Company will soon be using electricity for power and light. Manager Reynolds, of the Northwestern, announces that the company is prepared to furnish farmers along its line with electricity for various uses and that he hopes to interest the people along the line to an appreciation of its advantages and use.

GIRARD, KAN.—The City of Girard outgrew its light plant and has erected a large modern plant, suitable to the new demands. It has for sale the old plant.

FORT LEAVENWORTH, KAN.—Bids are wanted December 20 for extending the electric lighting system at this post. Address Maj. D. E. McCarthy, Quartermaster, U. S. A.

DAMARISCOTTA, ME.—The Twin Village Water Company is making active preparations to install an electric lighting system to serve Damariscotta and Newcastle. The power at the station has been increased during the past summer.

NORTH ADAMS, MASS.—The Stamford Power, Heat & Light Company has been granted a charter by the Vermont Legislature, and the concern will be capitalized at $8000. The North Adams Gas Company will run wires to the State line, and there transfer its current to the Stamford Company, which will light the streets and buildings in the town.

HOLYOKE, MASS.—Manager W. H. Snow, of the gas and electric light department, has advertised for bids for three 250-hp Manning upright tubular steam boilers, and for a 750-hp vertical cross compound steam engine attached to a 500-kw, three-phase, 2300-volt generator, alternating current. Bids will be opened December 15. Plans and specifications may be found at the office of the manager at the city hall.

ALAMO, MEX.—The Alamo Electric Power & Milling Company, of Alamo, Lower California, will establish an electric power plant for operating machinery at its gold mines.

CITY OF MEXICO, MEX.—David R. Retana, of this city, has made application to the Mexican Government for a concession to establish a large hydraulic power plant on the Poliutla River in the State of Guerrero. He will also establish a large system of irrigation in that State.

MONTEREY, MEX.—The Monterey Water, Sewer & Power Company has been incorporated with a capital of $4,000,000, to purchase, construct, equip water works, sewer systems, gas and electric plants, etc., at Monterey. Incorporators: J. J. Jermyn, Chas. H. Well, of Scranton, Pa., and Jas. D. Stonaker, of Jermyn, Pa., and Louis B. Daily, of East Orange, N. J., and others.

CITY OF MEXICO, TEX.—The new plant of the Mexico Gas & Electric Light Company has been formally inaugurated in the presence of the president

and a distinguished company. The plant of the company at San Lazaro is one of the most substantially constructed and up-to-date establishments of its kind in the entire republic. The machinery installed was obtained from the United States and England. The plant represents an investment of £400,000 sterling, or nearly $2,000,000 gold.

IRON MOUNTAIN, MICH.—The $1,000,000 power plant at Iron Mountain, Mich., owned by the United States Steel Corporation, has been gutted by fire.

JOPLIN, MO.—The municipal light plant, located in East Joplin, was destroyed by fire early on the morning of November 20. The loss will be about $75,000.

ST. JOSEPH, MO.—The Board of Public Works has accepted the bid of the General Electric Company, of Schenectady, for electric lighting, which, although not the lowest, will result in a large saving. The bid was $29,712.

MARYVILLE, MO.—Hopkins, a town of 1200 in Nodaway County, celebrated the completion of a municipal lighting plant November 19. Maitland, another town of the same size, also turned on the light from its electric plant.

ST. LOUIS, MO.—The Security Electric Heating & Power Company, of St. Louis, was incorporated November 30, with a capital stock of $300,000, all paid. The incorporators are Samuel D. Winter, Dudley S. Wagley, Harry M. Hill, Robert E. Williams and Sim D. Price.

ST. LOUIS, MO.—A building permit was granted the Union Electric Light & Power Company, November 30, for the erection of a sub-station at No. 709 North Fourth Street, to cost $26,000. Excavations are now nearly completed for another building to be used for the same purpose on South Fourth Street, between Market and Walnut.

ST. LOUIS, MO.—Owing to the fact that a bill providing for a new lighting contract for the section of the city south of Keokuk Street is being held up in the House of Delegates, the board of public improvements may have to take charge of the lighting problem there upon the expiration of the present contract, on February 1. The supervisor of city lighting says that he has been arranging to continue the lighting on an emergency basis at the expiration of the existing contract if a new one is not let in the interim.

ATLANTIC CITY, N. J.—The Oliver Electric Company, of Atlantic City, has filed a certificate of dissolution.

TROY, N. Y.—A certificate filed with the Secretary of State announces that the Troy Electric Company, of Troy, has paid in half of its capital stock, which amounts to $5000. The certificate is signed by W. C. De Voee, Edward R. Robinson and Charles A. Hinsdell.

NEW ROCHELLE, N. Y.—The new interests which control the Westchester Lighting Company, capitalized for $22,500,000, held a directors' meeting and promoted F. A. Stratton, of Mount Vernon, to the place of president. Mr. Stratton has served as vice-president of the corporation for six years, in which time he has extended its electric and gas plants to 22 cities and towns in Westchester County and the Bronx.

ALBANY, N. Y.—The Queens-Nassau Electric Light & Power Company has been incorporated to supply gas and electricity in the counties of New York, Nassau, Queens, Kings, Suffolk, Richmond and Westchester. The capital is $100,000, and the company's business office will be located at Valley Stream in the town of Hempstead, Nassau County. The directors are G. F. Swinnerton, of New York City, A. Foshay and R. K. Thompson, of Brooklyn.

RALEIGH, N. C.—The Secretary of State has issued a charter to the Mt. Olive Light & Power Company, of Wayne County, which is organized with an authorized capital stock of $100,000, $10,000 paid in. Incorporators and shareholders are X. T. Keel, Wm. Maxwell, J. W. Williamson, J. A. Smith, M. T. Buazelae, D. B. English, L. P. Aaron and J. W. Keel.

CLEVELAND, OHIO.—Bids will be received Dec. 20 by the Board of Trustees, Cleveland State Hospital, for furnishing and installing a 175-hp engine, a 100-kw generator and a 5-panel switchboard. A. B. Howard, M. D., is secretary.

CLEVELAND, OHIO.—An ordinance has been introduced in the City Council granting a franchise to the Cuyahoga Light & Power Company. The franchise ordinance has a municipal ownership clause so as to permit the city to take over the plant at some future time if it may legally do so. It is stated that the project is backed by Pittsburg, eastern and Cleveland capital.

CANTON, OHIO.—At a special meeting of the City Council a franchise was granted to the Citizens' Light, Heat & Power Company.

CHAMBERSBURG, PA.—The borough of Chambersburg offers for sale or lease the electric light plant now owned and operated by the borough.

PITTSBURG, PA.—Robert C. Hall, of Pittsburg, active in the promotion of the new Duquesne Light Company of Pittsburg, states that the company will expend $2,500,000 in erecting one of the most modern and complete electric lighting plants in the country and that the interests in control of the Pittsburg & Allegheny Telephone Company were in control of the light company.

WAKEFIELD, R. I.—The Wakefield Mills have purchased from the Westinghouse Electric Company a 50-hp three-phase motor, which will be utilized in running the major portion of the plant, the electric power being furnished by the electric light company at Narragansett, R. I.

GEORGETOWN, S. C.—At the annual meeting of the Georgetown Electric Company in this city the company was reorganized and the following officers elected: President, H. C. Case, Philadelphia, Pa.; vice-president and general manager, S. S. Ingman, Florence; secretary and treasurer, S. C. Case, Philadelphia, Pa.; local superintendent and manager, L. Mouzon, Georgetown.

WALHALLA, S. C.—The Oconee River Water, Light & Power Company, incorporated at Walhalla with a nominal capital stock of $125,000, will develop about 700 horse-power at a point 7 miles from Walhalla, and transmit energy by electricity to that town and its vicinity. New York capital will be largely interested. The incorporators are James Thompson and William J. Striblong, of Walhalla, and W. B. Frink, of New York.

CHARLESTON, S. C.—The Broad River Light & Power Company, incorporated with a capital stock of $1,000,000, will build a power plant to supply electric power to the cotton mills of Spartanburg and Union counties, also to other manufacturing plants; will build a ten-foot dam, 1000 feet long, to develop 15,000 horse-power, and this will be transmitted a distance of 20 miles. A canal one and one-half miles long will be constructed and be connected to the power house by four steel flumes. P. J. Balaguer is president, E. W. Wynne, vice-president, and F. K. Myers, secretary-treasurer.

BELTON, S. C.—The Belton Power Company, which has filed for record a mortgage on its plant for $300,000, has raised by its bond issue money to begin construction of its dam and power house on Saluda River. The contract for constructing the dam has been awarded to the J. F. Gallivan Building & Construction Company, of Palmer, Mass., and work has already begun. The dam is to be 600 feet long, 32 feet high and 35 feet wide, of concrete and stone, and is expected to develop 5000 horse-power. This energy will be transmitted to Belton and neighborhood to furnish electric lights and all kinds of industrial plants. J. E. Sirrine, of Greenville, is the engineer in charge.

SPEARFISH, S. D.—The new electric light plant at Spearfish is in operation. It cost $50,000.

YANKTON, S. D.—Yankton Improvement Company has been incorporated to build and operate an electric light and gas plant in this city. Capital $100,000.

KIRBYVILLE, TEX.—An electric light plant is to be installed here.

UVALDE, TEX.—A. M. Fisher, of Waco, Tex., will probably install an electric light plant at Uvalde.

DALHART, TEX.—The Dalhart Ice & Electric Company will install an electric light plant at Dalhart.

EL PASO, TEX.—The El Paso Gas & Electric Company, has been incorporated with a capital of $500,000. The incorporators are William Barrett Ridgely, of Washington, D. C.; George Goodnow, of Waukegan, Ill.; Fletcher S. Heath, Frank R. Crane and Edward Clifford, of Chicago, Ill., and George D. Flory and Charles Barrett, of El Paso, Tex.

NEWPORT, VT.—The Newport Electric Light Company is putting in a new switchboard at a cost of $1500.

RUTLAND, VT.—A bill has been introduced in the Legislature granting permission to this city to establish a municipal electric light plant. J. S. Carder is Mayor.

ST. ALBANS, VT.—The electric power from Fairfax Falls has been turned on to this city. The Vermont Power & Manufacturing Company, whose stock is owned principally in Philadelphia, Pa., and Pittsfield, Mass., was formed for the purpose of buying the Fairfax Falls and installing an electric power plant there. Its officers are: President, C. C. Chesney, of Pittsfield, Mass.; vice-president, George M. Bunting, of Philadelphia; secretary, H. Bayard Hodge, of Philadelphia; general manager and treasurer, W. H. Vorce, of St. Albans. The reduction in the price of electricity to consumers since the installation of the new plant is 40 per cent.

CAPE CHARLES, VA.—Bids will soon be asked for the purchase of an electric light franchise. I. J. Burbage is City Clerk.

RICHMOND, VA.—The city has formally taken possession of its new electric pumping plant, which has been in course of construction for a year. It has 500 horse-power, and will pump 2000 gallons of water per minute.

COLONIAL BEACH, VA.—The Colonial Beach Electric & Power Company, of Colonial Beach, has been incorporated by Warren S. P. Combs, F. F. Ninde and W. Frank Renshaw, of Colonial Beach; capital, $25,000.

BALLARD, WASH.—Louis V. Brewer has petitioned for a franchise for an electric light plant.

GOLDENDALE, WASH.—The City Council has granted R. T. Robinson a franchise for an electric light plant.

CLARKSTON, WASH.—The Lewiston-Clarkston Company has raised $2,000,000 by bond and will make extensive improvements and greatly enlarge its power plants. An auxiliary electric plant of 1000 horse-power has been commenced at the mouth of the Clearwater River. The Asotin plant will be enlarged from 600 horse-power to 2500 as soon as the auxiliary at the mouth of the Clearwater is completed. As soon as these works are finished work will be commenced on a 600 horse-power plant on the Grand Ronde River from which Snake River mines will be supplied with electrical power. An electrical railway from Clarkston through Lewiston, Ida., will be built when the Asotin power plant has been enlarged. The company has run a wire to Genesee and Moscow, Ida., and soon will furnish these towns with power.

SEATTLE, WASH.—Opposition to the Seattle Electric Company, owned by a syndicate of Boston capitalists, has assumed a formidable aspect, through the consolidation of the Snuoqualmie Falls & White River Power Company, the Seattle Cataract Company and the Tacoma Cataract Company into the Seattle-Tacoma Power Company, with a capitalization of $3,500,000. The new company will compete with the Boston company for the lighting and power business of western Washington. The president of the new company is N. H. Latimer, general manager of the Dexter-Horton Bank, the largest bank in Seattle. The interests participating in the deal include prominent Seattle and Tacoma capitalists, the estate of the late W. T. Baker, of Chicago, which holds a majority of the stock in the new company, George Westinghouse, of Pittsburg, and N. W. Harris & Company, of Chicago. A large issue of bonds to cover the work of developing 50,000 to 60,000 additional horse-power is soon to be placed on the market.

NEW RICHMOND, WIS.—An engineer has recommended improvements at the electric light plant.

LA CROSSE, WIS.—The Board of County Supervisors has voted to install a lighting plant to light the county buildings.

KENOSHA, WIS.—Mayor Gorman has recommended to the City Council that it have a municipal electric light plant ready to operate when the present contract for lighting the city expires.

THE ELECTRIC RAILWAY.

SILOAM SPRINGS, ARK.—The Siloam Springs Electric Railroad, Power & Improvement Company has been organized here, with a capital stock of $500,000. The incorporators are Mayor D. Zimmerman, C. Harrington and Dr. J. A. Rigen, E. C. McCullouch, W. T. LaFollette and G. H. Henderson.

DOWNIEVILLE, CAL.—It is planned to build an electric railway from Marysville to Downieville via Brown's Valley, Challenge and the North Yuba River. This project is to be known as the Sierra & Yuba Electric Railway & Power Company. George Morse, of Downieville, is interested.

ROCKVILLE, CONN.—The contract for the construction of the Rockville, Broad Brook & East Windsor Street Railway has been taken by Thomas C. Perkins, of Hartford.

NEW HAVEN, CONN.—With the driving of two silver spikes November 22, thus joining the local street railway lines of this city the Wallingford Electric Railway at what is known as Muddy River, about 10 miles north of the city, the last link in the trolley line between New York and Boston was made complete.

AMERICUS, GA.—The American Gas & Electric Company, of Providence, R. I., represented by S. N. Blake, has applied to the City Council for a franchise to build an electric plant and 4 miles of street railway.

MACON, GA.—The Jefferson & Athens Railway Company has been chartered by the Secretary of State, with a capital stock of $50,000. The road will be 18 miles in length and will run between Jefferson and Athens, Ga.

CHICAGO, ILL.—The Evanston Interurban Railway Company has been incorporated to build an electric railway in Evanston. Dr. E. P. Clapp, J. W. Work, J. F. Kennie, Andrew Simpson and C. H. Poppenhausen are the incorporators. The office of the company is 1575 Sherman Avenue.

LAFAYETTE, IND.—The Fort Wayne & Wabash Valley Traction Company, which owns the local street car system, announces that the new $200,000 power plant will be erected here. The company will first build a line from Logansport to this city via Delphi, and thence to Danville, Ill. When the system is completed the eastern terminal will be in Lima, Ohio, and the western in Champaign, Ill.

INDIANAPOLIS, IND.—The Indianapolis, Newcastle & Toledo Electric Railway Company has been incorporated, with a capital of $3,500,000, to build a total of 140 miles of electric railway, with a main line from Indianapolis to Winchester, through Newcastle, and several branches. The directors of the company are D. M. Parry, of Indianapolis, president; Charles S. Hernly, of Newcastle, vice-president and general manager; F. M. Ingler, of Newcastle, secretary and general counsel; Robert Churchman, of Indianapolis, treasurer, and W. E. Stevenson, of Indianapolis.

COUNCIL BLUFFS. IA.—Frank Keyes, T. G. Turner and C. H. Chisam are interested in a project to construct an electric railway from Council Bluffs to Carson.

DES MOINES, IA.—The organization of the St. Joseph, Albany & Des Moines Railway Company was completed last week by the filing of articles of incorporation with the Secretary of State. Des Moines is made the principal place of business, and the authorized capital stock is placed at $25,000. The officers of the company are F. S. Mordaunt, president; Wallace Hubbard, vice-president; Joshua B. Thomas, treasurer; E. H. McVey, secretary.

RICHMOND, KY.—A. J. Whaleburg and William Lang, of Detroit, Mich., are promoting an electric railway between Lexington and Richmond, Ky. The Chamber of Commerce of Richmond is interested in the scheme to build the line.

NEW ORLEANS, LA.—The city of New Orleans offered at public outcry a few days ago a franchise for an electric street railway in Algiers, to extend over a period of fifty years. Leigh Carroll, president of the Algiers Water Works & Electric Company, was the only bidder, whose proposal was one-half of 1 per cent of the gross receipts, less city and State taxes. It is probable the franchise will be secured by Mr. Carroll.

CUMBERLAND, MD.—A certificate of incorporation has been granted a company to operate a passenger railway from Cumberland to Mount Savage, from Corrigansville to Ellerslie and from Barrellville to the Pennsylvania State line, a distance of less than 12 miles in length. The capital stock is $50,000. The incorporators and directors are George Clinton Uhl, Mount Savage; Dr. William Oliver McLane, Frostburg; John Henry Holzshu, James A. McHenry and Charles G. Holzshu.

BOSTON, MASS.—There is no longer any question that the proposed Boston & Providence Street Railway will be built. The Boston & Worcester Street Railway interests are behind the Boston & Providence Company and a large portion of the right of way between Boston and Providence has been secured and construction will begin in the spring. The line will be built through Newton, Needham, Dover, Walpole, Norfolk, Wrentham, North Attleboro and Attleboro to the Rhode Island State Line.

NILES, MICH.—Articles of incorporation have been filed with the Secretary of State by the Niles & Buchanan Railway Company, organized with $25,000 capital.

KALAMAZOO, MICH.—The St. Joe River Traction Company has been organized with a capital of $750,000, to build an electric railway from the Indiana line through Benton Harbor to Kalamazoo.

ESSEX FELLS, N. J.—It is stated that plans are under consideration by the Erie Railroad, the Morristown and Erie, which connects with Erie at Essex Fells, and the Public Service Corporation to connect Newark by trolley direct with Morristown over the tracks of the Morristown and Erie. The plan provides for the electrification of the Morristown and Erie so that trolley as well as steam cars can be operated on the line. The Morristown and Erie road is only 11 miles long and may be equipped readily electrically, with either third rail or the overhead system.

ROCHESTER, N. Y.—The Albion & Rochester Electric Railway Company has applied for a franchise to extend its line.

NEW YORK, N. Y.—Early November 26 the elevated section of the subway in the Bronx, extending from 149th Street to 180th Street, was opened for traffic.

NORTH TONAWANDA, N. Y.—The Niagara Transit Company has been incorporated here. Capital $210,000. W. M. Mills, L. C. Denruff and others are incorporators.

NEW YORK, N. Y.—The engineers of the Rapid Transit Commission have approved the proposal for a tunnel in Thirty-Fourth Street to be provided with moving platforms.

SYRACUSE, N. Y.—The Auburn & Syracuse Electric Railroad Company has decided to expend $100,000 in double tracking five miles of its road west of the city limits and to purchase new cars and other equipment.

ROME, N. Y.—Dr. J. Pillmore, W. G. Dennison and G. V. Evans, of Delta, and A. R. Kessinger, of Rome, have been appointed a committee by the Citizens' League and Employers' Association, of Rome, to consider the advisability of building an electric railway between Rome and Delta.

SYRACUSE, N. Y.—The Syracuse & Suburban Electric Railway will extend its tracks 500 ft. into the village of Jamesville and build a terminal station there. The Jamesville Village Board has decided to widen the roadway so as to allow the extension. The new station will be 15 ft. x 25 ft.

LONG ISLAND CITY, N. Y.—The Central Long Island Company has applied for a franchise to construct and operate a trolley line from Cold Spring Harbor, Long Island, through the Summer resort towns on the north side, to Mineola, where it will meet the eastern terminus of the line by which Mineola is connected, through Hempstead, Freeport and Queens, with the city. There is to be a public hearing on the application before the Nassau County Board of Supervisors on Monday, Dec. 12, in the courthouse at Mineola. The proposed line is to form a part of the comprehensive scheme that contemplates the north shore of Long Island by trolley from Flushing to the eastern end of the island, or Orient Point. The Central Long Island Railroad Company plans to lay sections of the road in large installments, such as that proposed between Cold Spring Harbor and Mineola. The road between these points will pass through Oyster Bay, East Norwich, Bayville, Locust Valley, Mill Neck, Glen Cove, Sea Cliff, Rosyln, Glen Head and East Williston.

CLEVELAND, OHIO.—The Cleveland Electric Railway Company will soon place a contract for a new storage-battery station to be erected on Broadway to take care of peak loads in that section of the city. The company now has three large battery stations in the city.

AKRON, OHIO.—The Akron-Alliance Connecting Railway Company has been reorganized, and C. L. Morgan, Gen. G. R. Gyger, Arthur Wright and others, of Alliance, have become identified with the project. The road was surveyed several years ago, but no work was done. It is now said that financial backing has been secured and that the road will be built.

TIFFIN, OHIO.—Detroit and Eastern capitalists represented by F. T. Banney and G. B. Fowler, of Detroit, are said to be negotiating to take over and consolidate the Toledo, Fostoria & Findlay Railway, the Tiffin, Fostoria & Eastern Railway and the Edison Company, of Tiffin. The traction companies operate lines connecting Findlay, Fostoria and Tiffin, Ohio.

GREENVILLE, PA.—The Cleveland, Geneva & Meadville Electric Railroad Company has been organized in New York City to build an electric railway between Cleveland and Meadville, Pa. It is estimated that $1,250,000 will be required to build and equip the line.

HARRISBURG, PA. A charter has been granted at the State Department to the Bradenville & Derry Street Railway Company, capital $36,000, to built a 6-mile electric railway from Latrobe to Bradenville, Loyalhanna, Snydertown and Derry. The directors are Stephen Stone, of Pittsburg, president; E. C. Gerwig, M. D. Vogel, J. J. Neelan and A. P. Meyer.

BLOOMSBURG, PA.—The charter of the Bloomsburg & Millville Street Railway Company has been recorded in this county. The capital stock is $60,000 and the officers W. Miller, president; L. E. Waller, C. C. Peacock, C. M. Creveling, J. C. Brown and F. E. Miller, directors. F. W. Darlington, of Philadelphia, will finance and construct the new line. Surveys will be commenced at once.

PROVIDENCE, R. I.—The Providence & Danielson Railway Company proposes to build a branch electric railway between Plainfield, Conn., and Foster Centre, R. I., connecting with the main line at the latter place. The company's main line connects Providence, R. I., and Danielson, Conn., a distance of 28 miles.

PROVIDENCE, R. I. —Owing to the Old Colony Street Railway Company's policy of centralization, its power plant located in Rehoboth is to be removed. This is one of the company's largest stations, and, together with power houses in Bridgewater, Taunton and other places, will have its machinery sold, with the view of establishing two or three large centres from which power will be carried through large feed wires. The central power plant will be at Quincy, Mass., where there will be a high voltage (3200), so that, with the aid of two large plants, one in Taunton and the other in Fall River, all lines will be supplied.

LAREDO, TEX.—The electric street railway system at Laredo, which is owned by G. Bedell Moore, of San Antonio, is to be extended and greatly improved. Frank E. Scovill has been made manager.

UVALDE, TEX.—The City Council of Uvalde has granted a franchise to J. H. Gerhart to construct and operate a street railway system in this place.

FORT WORTH, TEX.—When all the improvements now contemplated by the Northern Texas Traction Company are made, the company will have expended more than $100,000. The capacity of the present power house at Hand-

ley will be increased just 50 per cent. The new addition to the power house will involve an expenditure of about $60,000. The Westinghouse Company has the contract for the machinery, while the engines are to be furnished by the Cooper Company, of Mount Vernon, Ohio. Besides these improvements, it is stated that the company proposes to double the tracks between Fort Worth and Handley.

OSHKOSH, WIS.—The Westinghouse office in Chicago writes us as follows: "In your issue of November 19 you had a paragraph under the subject of light and power, to the effect that at Oshkosh, Wis., the Westinghouse Elec. & Mfg. Company was preparing plans and specifications for a new road from Oshkosh to Berlin. This information is not correct, as we are not connected in any way with this project and believe that Mr. Clement C. Smith, of Milwaukee, is acting as engineer."

HAMILTON, ONT.—It is said that the Hamilton Street Railway Company, of Hamilton, Ont., is anxious to sell its property and franchise to the city. It can be bought for some $800,000 or $900,000.

CASAS GRANDE, MEX.—A project is on foot to construct an electric railway from Casas Grande to the Guerrero basin, a distance of 80 miles. It is said that an American syndicate is promoting this project and that the survey for the proposed line is now being made H. C. Daugherty, of Jesus Maria, State of Chihuahua, can give information in regard to the enterprise.

OTTAWA, ONT.—The directorate of the Ottawa Electric Street Railway Company has offered to sell to the city of Ottawa, in response to an invitation from the City Council, its whole property and franchise for $3,000,000, which is equal to $250 per share of the company's stock. The company will accept payment in four per cent. municipal bonds. The stock is now selling at about $210 a share. An expert inquiry will be made by the city into the whole matter before the proposal to purchase is submittetd for ratification to the ratepayers in January next.

NEW INDUSTRIAL COMPANIES.

THE SELECTIVE SIGNAL & TELEPHONE MFG. COMPANY, of Sycamore, Ill., has been incorporated with a capital of $100,000, by J. C. Joslyn, E. F. Buell and C. A. Bishop.

THE BABCOCK ELECTRICAL COMPANY, of Rochester, N. Y., has been incorporated with a capital stock of $50,000. The incorporators are Garrison Babcock, J. L. Hotchkiss and C. T. Chapin, Rochester.

THE KIMMEY ELECTRIC LIGHT DISPLAY COMPANY has been incorporated at Portland, Me., capital $1,000,000, nothing paid in. President, M. W. Baldwin; treasurer, G. C. Knight, both of Portland.

THE CURTIS AUTO COMPANY, of Brooklyn, N. Y., has been incorporated, with a capital stock of $1000. The incorporators are Charles G. Curtis, Van Wyck Curtis and Alice W. Curtis, Brooklyn.

THE BANNER ELECTRIC & MANUFACTURING COMPANY, of Oklahoma City, Okla., has been incorporated with a capital stock of $10,000. The incorporators are Charles Luck, Charles Risdon and Warren Snyder.

THE SOUTHERN ELECTRICAL MANUFACTURING COMPANY, LTD., has been incorporated at Covington, La. The corporation is capitalized at $200,000. The officers are E. Y. Ames, of Covington, president; Arnold Heller, of New York, vice-president, and E. J. Frederick, of Covington, secreary-treasurer. The company, it is said, has secured control of all the patents on the Simplex arc light, and will manufacture the lamps here.

THE KOKOMO ELECTRIC COMPANY, of Kokomo, Ind., has filed articles of incorporation with the Secretary of State. The capital stock is $12,500. The company proposes to carry on a general manufacturing and trading business in electrical supplies and appliances and particularly motors of all kinds, coils, sparks plugs, x-ray apparatus, wireless telegraph apparatus, batteries, etc. George Kingston, J. W. Johnston, E. S. Huff and J. P. Grace are the incorporators.

LEGAL.

NEW YORK CONDUITS.—Proceedings are being taken by Corporation Counsel Delany against the Consolidated Telegraph & Electrical Subway Company to compel an accounting to the city and the recovery of some $5,000,000 held to be due. Litigation of one sort or another has been under way between the city and the Consolidated Subway Company for many months. At that time action for an accounting and recovery was begun by Corporation Counsel Rives, but the Subway counsel filed a demurrer which was sustained in the courts. This required the new action brought by Corporation Counsel Delany. In this latest action the companies will be represented by Mr. Elihu Root. The contract of the Consolidated Telegraph & Electrical Subway Company with the city was secured in 1886. The company was to construct and maintain subways for gas pipes and electric wires. Later the Empire City Subway Company was formed on the same terms. It was owned by the same interests which later brought the two companies together. All of the subway stock is controlled by the Consolidated Gas interests. Under the terms of the contract the subway company was to be permitted by the city to earn 10 per cent. on its investment without assessment, but of all profits over this 10 per cent. the city was to get one-third. The promoters of the company floated bonds to the amount of $3,000,000, and in the new action against the company it is charged that these bonds were sold to insiders at 60 and 90, and that in order to prevent the city from getting its share of the profits the bonds have been held as issued at par, and also that the city has been charged 6 per cent. interest on money raised on the bonds to build the subways. It is alleged that the city never has received anything from the subway company, whereas more than $5,000,000 should have been turned over. The Consolidated Telegraph & Electrical Subway Company has outstanding 18,750 shares of stock. According to the last available report of Sept. 28 last, these are some of the stockholders and their holdings: Theodore P. Anderson, 167 shares; Anthony N. Brady, 120; Charles R. Gilbert, 550; Horace M. Kilbourne, 2000; Edward Lauterbach, 100; New York Edison Company, 138; State Trust Company, as trustee, 15,160; William Woolverton and C. H. Cutter, as trustees, 261.

PERSONAL.

MR. R. A. C. SMITH, well known in connection with financial affairs in light and traction, has been elected a director of the Metropolitan Street Railway of New York.

MR. J. G. WHITE, president of J. G. White & Company, New York City, sailed for New York from England, December 16, after several months' sojourn on the other side.

MR. ROBERT K. MICKEY, formerly assistant sales manager of the National Carbon Company, has resigned in order to join the staff of the American Carbon & Battery Company, of St. Louis.

MR. JOHN CRAIG HAMMOND, of Denver, has been appointed chairman of the local advertising committee for the Colorado convention of the National Electric Light Association, by Mr. Henry L. Doherty, who is chairman of the general committee of arrangements. Mr. Hammond is well known in the Western journalistic field, and his efforts will do much to render the next convention a brilliant success.

VISIT OF THE ROTHSCHILDS.—Baron Alphonse and Baron Louis Rothschild, now in New York, are the sons of Baron Albert Rothschild, head of the Austrian branch of the international banking house of that name. Both of them are officers of the Sixth Dragoon Regiment of the Austrian army. Their father's position, and in a lesser degree their own, are altogether exceptional in Viennese society. They are understood to be here in connection with further great projects connected with passenger transportation in New York City.

MR. R. W. MEADE, who succeeds Mr. H. Sanderson as president of the New York Transportation Company, has been associated with it for some time past, as well as with the New York City Railway Company, to whose president he was made assistant in 1902. He is a young man of considerable railroad experience, dating from 1889, and for some time was in the service of the New York Central. He has given particular attention to the problems of handling, storing and distributing freight, and has excellent qualifications for his new post, with whose duties he is already well acquainted.

MR. ALBION D. T. LIBBY, E. E., for the last four years power engineer of the Kellogg Switchboard & Supply Company, has resigned that position to become associated with the Dean Electric Company, of Elyria, Ohio. Mr. Libby received his first telephone training at the Western Electric Company, Chicago, Ill., having served successively in its shop, telephone experimental laboratory, installing department and engineering department. While with the Kellogg Company he had charge of the designing and constructing of all of its power equipment, which included much original investigation. He will have direct charge of the power engineering and supervision of installation for the Dean Electric Company. Mr. Libby was responsible for some of the first complete and efficient power plants in the independent telephone field.

MR. G. C. FRICKE, who since February, 1901, has been purchasing agent for the Standard Telephone & Electric Company, of Milwaukee, has accepted a position as traveling representative for Frank B. Cook. Mr. Fricke's experience in the telephone field dates back to 1896, when he was in the cable department of the Western Electric Company. He was transferred from the cable to the switchboard department, and later was taken into the office. In November, 1899, he accepted a position with the Kellogg Switchboard & Supply Company, having charge of the stock room for a short time, and then going into the purchasing department in the capacity of assistant purchasing agent. This position he held until he resigned to take charge of the purchasing for the Standard Telephone & Electric Company. Mr. Fricke, during the eight years in which he has been actively interested in the telephone business, has made many friends, and is well qualified to represent Mr. Cook in his large and growing business.

MR. E. D. ADAMS.—The gift of $50,000 by Edward D. Adams, in memory of his son, Ernest K. Adams, to Columbia University, New York City, for the foundation of a physical research fellowship was announced this week at a meeting of the university's trustees. The gift is accompanied by a valuable collection of scientific apparatus to be allotted to the electrical, physical and psychological laboratories of the university. All of this interesting apparatus was designed and worked out by Mr. E. K. Adams, and is described in the remarkable two volumes of his researches, reviewed in these pages a few months ago. This young scientist was a graduate of the electrical engineering course at Columbia, as well as a student at other universities. Mr. Ernest Adams died last July. In his memory the gift is called the "Ernest Kempton Adams Fund for Physical Research." The income is to be applied to the stipend of a fellow of the university and to the publication of the results of his investigations. The research fellow may be appointed from among the faculties, teaching staff, alumni or students of Columbia. He will be expected to carry on, either at Columbia or elsewhere, some particular research in a branch of the physical sciences. Part of the annual income of the fund will be applied to the publication and free distribution to scientific libraries and investigators of the results of his investigations.

MR. HENRY SANDERSON.—The retirement of Mr. Henry Sanderson as president of the New York Transportation Company was made the occasion, last week, of the presentation to him, by the executive staff and employes of the company, of a testimonial in the form of a handsome desk set of Tiffany bronze, and engrossed and framed resolutions. Mr. Sanderson has held the office of president since April 9, 1900, and is succeeded by Mr. R. W. Meade. The presentation speech was made on behalf of the donors by Mr. Herbert H. Vreeland, president of the Metropolitan Street Railway Company, and a

warm personal friend of Mr. Sanderson. The occasion, therefore, had the added interest of bringing together the two personalities that have been most prominent in developing two modern methods of passenger transportation—street railways and electric automobiles. Mr. Vreeland dwelt briefly upon the fact that the present enormous business of the New York Transportation Company has practically been created during Mr. Sanderson's incumbency. Four years ago the electric cabs were still a novelty, and their operation was surrounded with difficulties which seemed well-nigh insurmountable. To-day they are a familiar and necessary part of metropolitan life. Mr. Vreeland paid a warm tribute to the executive ability, the sound judgment and the absolute refusal to admit any problem impossible of solution with which Mr. Sanderson has fought adverse conditions and brought about the present prosperity of the company to whose interests he has been devoted. He elicited a particularly hearty response from his audience when he spoke of those characteristics of Mr. Sanderson's which enabled him, while holding the interests of the company supreme, to win and retain the loyalty and affection of his subordinates. In replying, Mr. Sanderson congratulated those who had been associated with him on the achievements of the past and the promise of the future. Five years ago, he said, the company's total station capacity was 72,000 square feet, and the company's vehicles in the course of a year covered 350,000 miles. To-day the combined floor area of the company's four stations aggregates 222,000 square feet—over five acres—and those stations house over five hundred vehicles, which, in the course of a year, reached the tremendous total of distance covered of 2,000,000 miles. He concluded with expressions of appreciation of the feelings which had prompted the presentation of the testimonial and of his regret at the severance of his connection with the company. Mr. Sanderson's resignation is the result of his decision to enter a new field of activity as a member of the firm of Edey, Brown & Sanderson, recently formed to do a general banking and brokerage business as members of the New York Stock Exchange. Mr. Sanderson will remain a director and member of the executive committee. His offices will be at 1 Wall Street, in the First National Bank Building.

Trade Notes.

THE LOWELL MODEL COMPANY, INC., has succeeded to the good will and property of the partnership formerly conducted under the same name. The company is located at Lowell, Mass., and engaged in the manufacture of gas and gasoline engines for all classes of work, including automobile propulsion.

THE GUARDIAN SAVINGS & TRUST COMPANY, of Cleveland, Ohio, has for sale an exceptionally well-located factory plant. Its railroad and shipping facilities are particularly good. The property comprises in the buildings its own power plant, lighting and heating systems. They offer all the advantages that a modern well-equipped manufacturing establishment possesses.

THE A. D. GRANGER COMPANY has moved its Philadelphia office to the Commonwealth Trust Building, Chestnut and Twelfth Streets, Philadelphia, Pa., where much larger and more commodious offices have been fitted up. Mr. T. M. Simpson remains as manager of this office, his territory covering the eastern portion of Pennsylvania, from Harrisburg to Philadelphia and the southern half of New Jersey.

THE SMITH STORAGE BATTERY COMPANY, of Binghamton, N. Y., has been sold to the Troy Plate Battery Company, of that city, which has taken over the equipment, patents, rights and franchises of the earlier company, and with increased capital and larger factory facilities will fill promptly all orders for the Smith tray plate battery, for light and power plants, as well as an improved cell type battery for automobile work. The headquarters are at 5 to 11 Frederick Street.

W. T. HUNT & SON is the name of a concern that has been established at 150 Nassau Street, New York City, to handle technical books of all kinds. Mr. Hunt, who has been well known in the electrical field for a great many years, has lately concentrated on this line of work, and as an engineering book specialist has built up a large connection in and around Greater New York. He makes a specialty of submitting books for examination to those with special requirements, especially engineers and practical mechanics.

S. F. ALDEN & COMPANY.—December 1, 1904, marks the first anniversary of S. F. Alden & Company, who as manufacturers' agents, are engaged in the sale of machinery, railway equipment and supplies, and various appliances for use in connection with gas and electric light plants, such as gas holders, poles, lumber, etc. Mr. Alden, who for many years has been engaged in constructing, rebuilding and operating various properties in different parts of the United States, besides being purchasing agent for many such companies, reports that the first year's business has been a very successful one. He represents several reliable and substantial manufacturing companies with useful lines of goods.

FOUNDRY CHAPLETS AND ANCHORS.—The loss from defective castings is an important item in the operation of a foundry. These losses are generally due to imperfect or badly constructed chaplets. W. W. Lindsay & Co., Philadelphia, Pa., are manufacturing chaplets and anchors perfected and patented by McCoy & Lunkens, which are designed to obviate these losses. These devices, which are described and illustrated in a pamphlet just issued by the first-named concern, are made of the best soft steel, which will bend double before it will break, permitting the heads to be given any desired shape for special work. The illustrations show double-head chaplets, single-head anchors, upset-head anchors and hook anchors, and tables and price-lists of the various sizes are given.

THE AMERICAN ELECTRIC FUSE COMPANY, of Chicago, has received from the official award committee of the St. Louis World's Fair a certificate showing the highest award upon its exhibit of telephone protective apparatus. This official certificate is a very handsome document and includes the blue ribbon awarded to the first prize. The inscription on the blue ribbon reads as follows: "Highest award awarded to the American Electric Fuse Company, Chicago, Ill., U. S. A., for excellence in telephone protective apparatus Department of Electricity." A number of duplicates of the official award have been ordered by the American Electric Fuse Company for the use in its various branch offices. The company is receiving the congratulations of its friends for having carried off this award.

MR. FRANK B. COOK has received from the Automatic Electric Company an order for a complete distributing and protector frame for the exchange of the Citizens' Telephone Company, at Columbus, Ohio. The capacity of the frame is to be 8100 pairs, and it will be equipped with 8000 pairs of Cook's No. 444 self-soldering protectors. This installation is especially worthy of note, as it is the largest protector board that has been installed for several months. Other orders which Mr. Cook has received from the Automatic Electric Co. are as follows: For the Delaware Telephone Co., Wilmington, Del., a type-L frame with a capacity of 1500 pairs, equipped with 2000 pairs of No. 444; for the Solvay Process Co.'s system, Syracuse, N. Y., 200 pairs; for the Home Telephone Co., Los Angeles, Cal., a 900-pair addition to the East Exchange; Home Telephone Co., Santa Monica, Cal., Type L frame —500 capacity—equipped with 300 pairs; for the Sawtelle Exchange—300 capacity—equipped with 160 pairs.

AIR COMPRESSORS AND VACUUM PUMPS.—An extensive line of air compressors and vacuum pumps is described in a 48-page pamphlet, 6x9 inches, just issued by the Clayton Air Compressor Works, of 114 Liberty Street, New York City. More than 21 types of machines are shown in the illustrations, including single and duplex machines, steam-driven, power-driven and electrically-driven, by gear, chain and belt. The last page also shows air compressors driven by direct-connected oil engines, forming small convenient units which may be installed almost anywhere and which are said to be used extensively in quarries, stone shops, small machine shops and all small plants where air is used for general purposes, such as cleaning, etc. Other pages describe the air lift, the uses of compressed air in car barns, vacuum machines for experimental work, etc. The range of sizes includes machines displacing from two cubic feet of free air per minute to those having a capacity of 1400 cubic feet.

THE ABNER DOBLE COMPANY, San Francisco, Cal., engineer, established 1850, has been awarded the grand prize for its exhibit at St. Louis of a 170-hp. tangential water wheel. The wheel developed 170 hp. at a speed of 700 r.p.m. with a water pressure of 300 pounds per square inch, equivalent to a hydraulic head of nearly 700 feet. It was direct connected to a 100-kw. railway generator and was one of the units of the intramural power plant. The wheel is of the tangential type with the Doble patented ellipsoidal buckets and is provided with a Doble patented needle regulating nozzle, operated by a governor. The sides of the wheel housing are made of plate glass so that the action of the water on the wheel can be observed. The quantity of water delivered to the wheel is measured by a Venturi meter with automatic recording instruments and the pressure of the water is registered by a recording gauge. The electrical output is measured by the switchboard instruments. A brief illustrated description of this exhibit has appeared in these pages.

THE ELECTRIC CONTROLLER & SUPPLY COMPANY, of Cleveland, Ohio, has just shipped the second of two 200-hp, 220-volt, type M. T. magnetic switch controllers to the Lorain plant of the National Tube Company. They are for the control of the reversing motors driving the tilting tables on each side of the plate mill. These controllers give automatic acceleration, which can be adjusted to the maximum rate consistent with safety to motors and gearing. When reversing from full speed forward to full speed reverse the table is automatically brought to a quick stop and accelerated in reverse direction in the least time interval consistent with safety. The magnetic controller with resistance is placed near the motor, thereby effecting economy in the use of heavy wire. The operating controller consisting of a small master switch, is conveniently mounted on the roller's pulpit, and since the contacts of this controller carry only only very light current, it may be operated with exceptional ease. The construction of the magnetic controller, however, is such that no matter how rapidly the operating controller may be reversed, the current flowing to the motor is automatically limited to a safe value. The M. T. controller is especially adapted to the control of motors of any horsepower driving machinery which must be quickly accelerated. Other recent shipments of controllers of this type have been made to the Carnegie Steel Co. and to the Lackawanna Steel Company; also to the Illinois Steel Co.

PUMPING MACHINERY is the title of a 132-page catalogue just issued by Henry Worthington, of 114 Liberty Street, New York City. The book is printed in two colors, the cover is lined and no expense has been spared to make a handsome machinery catalogue. The half-tone cuts, printed in black upon a high grade of coated book paper, stand out effectively from the reading matter printed in sepia. The cover is printed in black, light green and gold upon a dark green background, the whole forming an excellent example of the engraver's and printer's arts. The apparatus described in this book comprises all of the many types of pumping, condensing and measuring devices developed by this well-known company in the 64 years of its existence, the most promient being the duplex steam pump, of which Henry R. Worthington was the inventor. Special designs of this type of pump are adapted to boiler-feeding, mine-pumping, removing air and circulating water for condensers, water-works service, fire service, etc., and it is remarkable to note that a water-works engine of this type, without fly whels, has given a duty of 174,000,000 foot pounds per thousand pounds of steam in a test made at the Central Park Avenue pumping station at Chicago. One of the illustrations shows the large turbine pumps supplying the cascades at the St. Louis Exposition. Although devoted to one compnay's products, this publication is, in reality, an encyclopedia of the best present practice in the design of pumping machinery and should be included in the library of every engineer and manufacturer.

H. T. PAISTE COMPANY, of Philadelphia, Pa., has brought out an admirable little pamphlet entitled "Window Lighting with Fielding Material." It illustrates and describes the use of these excellent adjuncts, and supplies estimates upon which can be based close calculations for other work, such as occurs all the time for the consideration of central station companies and isolated plants connected with stores, etc.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOV. 29, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

775,933. ELECTRIC SWITCH; Isaac H. Parsons, Leicester, England. App. filed Feb. 23, 1904. The end of a rheostat arm drops between pins when it has been moved to squarely engage one of the contacts.

775,986. INSULATOR; Samuel Oakman, Cheshire, Mass. App. filed Nov. 7, 1903. The skirt of the insulator is broad and the space between its interior and the pin socket is to be filled with parafin.

775,993. GUARD FOR TROLLEYS; Joseph B. Short, Wilkinsburg, Pa. App. filed March 1, 1904. Details.

776,001. TRANSFORMER; William L. Waters, Milwaukee, Wis. App. filed Aug. 18, 1904. The coils are arranged with vertical passages between them and the casing contains openings for the inlet and outlet of air for ventilation purposes.

776,028. SPEED GOVERNOR; Homer N. Motsinger, Pendleton, Ind. App. filed Sept. 21, 1903. A lever carrying a pawl is reciprocated to drive an armature by engaging a ratchet on the armature shaft. An electro magnet in circuit with the armature lifts the pawl out of the ratchet when the current rises above the normal.

776,059. MEANS FOR COUNTERACTING ARCS; Rudolph E. Hellmund, New York, N. Y. App. filed Nov. 27, 1903. The arc in an oil switch is disrupted by agitating the oil at the instant the contacts separate.

776,062. ELECTROMEDICAL APPARATUS; William Hirschorn and Fritz Lowenstein, New York, N. Y. App. filed Nov. 11, 1903. A box containing apparatus for applying electrical oscillations to the body and constructed for convenient manipulation.

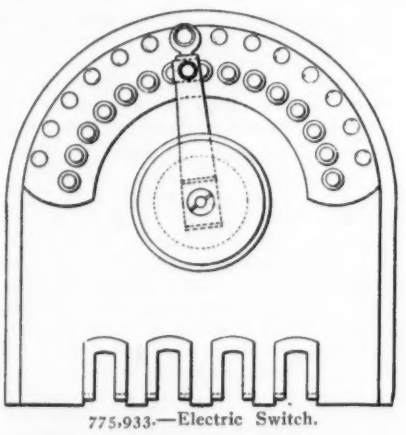
776,064. TROLLEY; William A. Holland, London, Ohio. App. filed Dec. 11, 1903. Details.

776,067. MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES; Milo G. Kellogg, Chicago, Ill. App. filed Nov. 30, 1891.

776,068. MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES; Milo G. Kellogg, Chicago, Ill. App. filed July 29, 1893.

776,090. TELEPHONE SYSTEM AND APPARATUS THEREFOR; Walter C. Runge, London, England. App. filed Dec. 6, 1902.

776,112. SANITARY ROTATING DIAPHRAGM FOR TELEPHONES; Sidney Churchhill-Otten, East Melbourne, Victoria, Australia. App. filed May 7, 1904.



775,933.—Electric Switch.

776,120. TRAIN ORDER PROTECTOR AND SIGNAL LOCK; Fryar E. Draper and Edward H. Roy, Nashville, Tenn. App. filed Jan. 5, 1904. The object is to place a check upon the operator and remind him of an order to be delivered and at the same time to notify the dispatcher of the condition of the signal.

776,144. AUTOMATIC ELECTRIC REGULATOR; Alexander McGary, LaGrange, Ill. App. filed April 20, 1903. A liquid container has a number of resistance terminals in its walls arranged at different elevations; the liquid is caused to rise and fall in the container to cover more or fewer of the terminals, by means of a plunger actuated by a solenoid.

776,154. CONTACT DEVICE FOR APPARATUS FOR LIGHTING OR EXTINGUISHING GAS; Fredrik Testor, Stockholm, Sweden. App. filed Aug. 16, 1904. The contact device is actuated by the movement of a bolt in a door lock.

776,160. TELEGRAPH KEY; Roye M. Wood, Chicago, Ill. App. filed May 9, 1904. The key lever is mounted on a spring and being resilient is said to be more rapid.

776,192. PROTECTIVE COATING OR COVERING FOR STORAGE BATTERY PLATES; Achille Meygret, Paris, France. App. filed June 29, 1903.

776,204. DENTAL HANDPIECE; Alson C. Sargent, Des Moines, Iowa. App. filed July 13, 1903. A small motor is mounted in the handle of a dental tool and directly connected with the tool point.

776,207. STAFF SYSTEM AND APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE-LINE RAILWAYS; Edward W. Smith, Chelsea, London, Eng. Improvements on that class of railway signals wherein staffs or bars are inserted in suitable openings in an instrument to alter the circuit as desired.

776,211. FLUORESCENT INDICATOR; Alfred T. Abbey and Frederick J. Esmond, Victoria, Canada. App. filed Aug. 28, 1903. A band provided with clamps for readily attaching it to a lamp socket, is coated with light emitting material to disclose the location of the lamp in the dark.

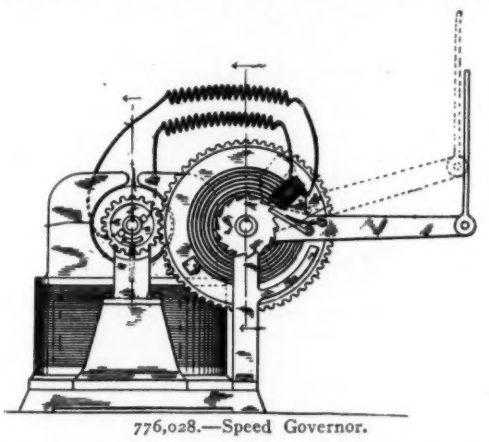
776,214. ELECTRIC RAILWAY SIGNALING SYSTEM; Marion A. Born, Lawrenceville, Ga. App. filed March 11, 1902. Details.

776,218. SELF SOLDERING HEAT COIL; Frank B. Cook, Chicago, Ill. App. filed Jan. 11, 1904. A fuse passes through the core of a heat coil. After the fuse is melted by an excessive amount of heat in the coil, it is restored to working condition and connection by the automatic cutting out of the coil and consequent reduction of heat.

776,220. CONTROLLER FOR ELECTRICAL VEHICLES; Henry H. Cutler, Milwaukee, Wis. App. filed April 15, 1903. A novel apparatus relating to the means for throwing the signals and locking them against disturbance.

776,223. MEANS FOR CONTROLLING THE VOLTAGE FROM ELECTRIC GENERATORS; Isidor Deutsch, Montreal, Can. App. filed April 30, 1903. Details.

776,238. ELECTRIC SWITCH AND SIGNAL APPARATUS; Lawrence Griffith, Yonkers, N. Y. App. filed Oct. 18, 1904. The voltage of a controlling circuit is varied at will to affect a number of magnet windings which actuate a reversing switch and an armature resistance.



776,028.—Speed Governor.

776,290. DEVICE FOR CONNECTING AND DISCONNECTING THE TALKING CIRCUITS OF TELEPHONES; Addington L. Brinckle, Philadelphia, Pa. App. filed March 23, 1904.

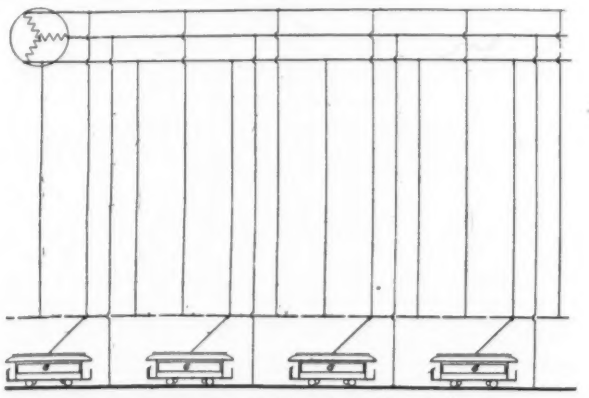
776,326. MULTIPLE ATTACHMENT PLUG; Harvey Hubbell, Bridgeport, Conn. App. filed Feb. 26, 1903. A porcelain block having sockets for a plurality of plugs whereby current can be distributed therefrom to a number of translating devices or groups thereof.

776,337. WIRELESS SIGNALING SYSTEM; Leonid Mandelstam, Berlin, and Hermann Brandes, Strassburg, Germany. App. filed Sept. 8, 1904. The receiving circuit has an alterable connection with the aerial conductor for the purpose of tuning it to the transmitter.

776,359. INDICATOR FOR ELECTRIC OSCILLATIONS; Adolf Slaby, Charlottenburg, Germany. App. filed July 26, 1904.

776,371. ELECTRICAL RAILWAY SYSTEM; William J. Alexander, Philadelphia, Pa. App. filed May 18, 1904. The invention comprises a tilting armature actuated by a magnet on the car to close branch circuits to the working conductor as the car passes along the same.

776,374. SYSTEM OF ELECTRICAL DISTRIBUTION; Bion J. Arnold, Chicago, Ill. App. filed Dec. 17, 1901. A polyphase system of distribution for railways wherein successive sections of a trolley wire are connected to different leads of the polyphase system to thereby equalize the load on said lead. The invention also comprises means for taking auxiliary current from the mains when it is desired.



776,374.—System of Electrical Distribution.

776,380. METHOD OF PRODUCING QUICK ELECTRICAL OSCILLATIONS OF DIFFERENT PHASES; Ferdinand Braun, Strassburg, Germany. App. filed July 26, 1904.

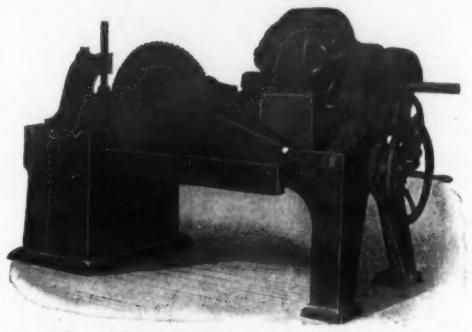
776,413. SWITCH-KEY; Frank R. McBerty, Evanston, Ill. App. filed May 9, 1902.

776,429. SERVICE-METER FOR TELEPHONE LINES; Charles E. Scribner, Chicago, Ill. App. filed April 9, 1900.

776,435. TELEPHONE EXCHANGE SYSTEM; Edwin H. Smythe, Freeport, Ill. App. filed May 24, 1902.

776,454. RHEOSTAT; Wm. Christersen, Philadelphia, Pa. App. filed Aug. 24, 1903. Ribbon coils of a rheostat are clamped upon a core by individual clamps having integral contact faces to be engaged by the switch lever.

776,480. PROTECTIVE COATING FOR STORAGE BATTERY PLATES; Achille Meygret, Paris, France. App. filed June 29, 1903.



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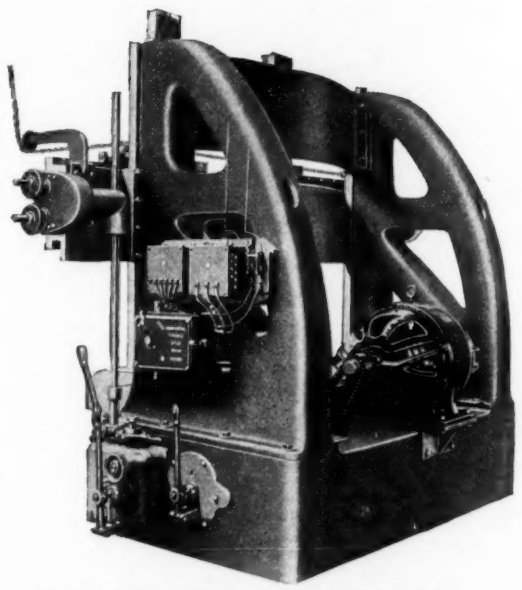

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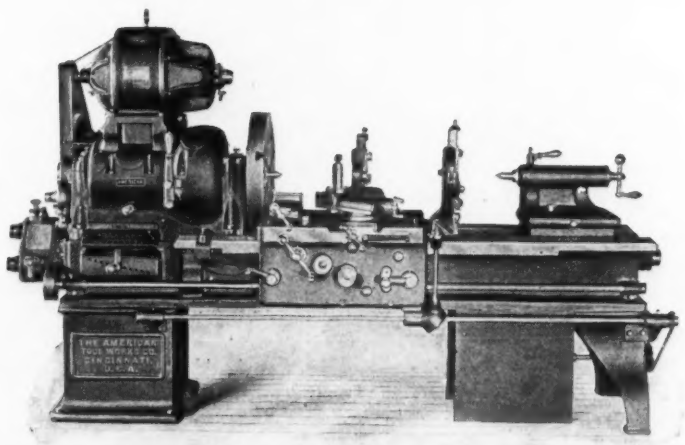

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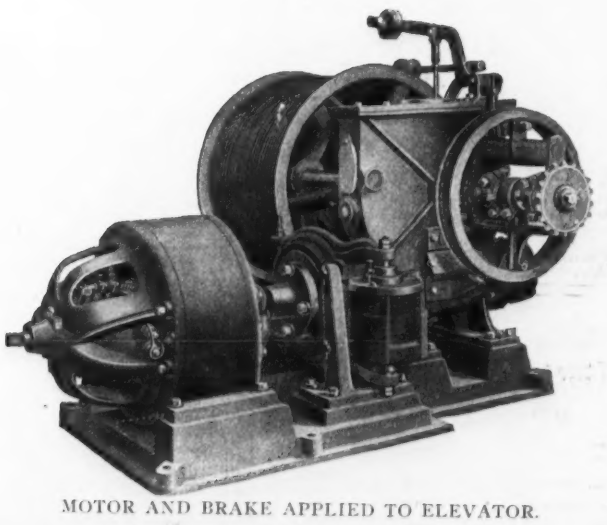

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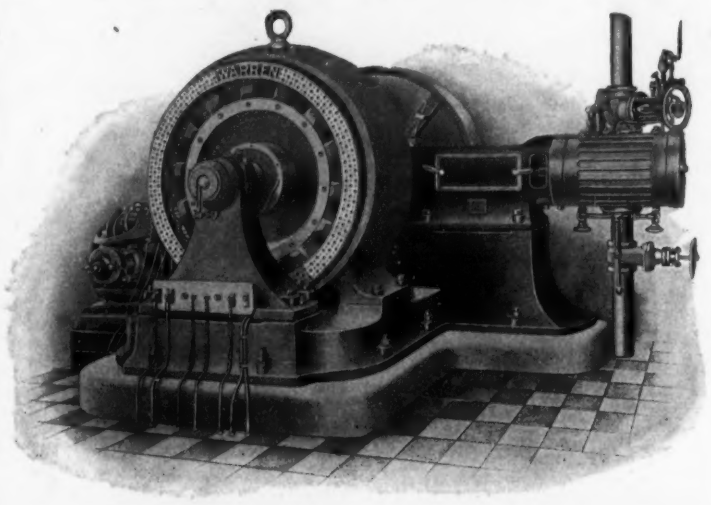

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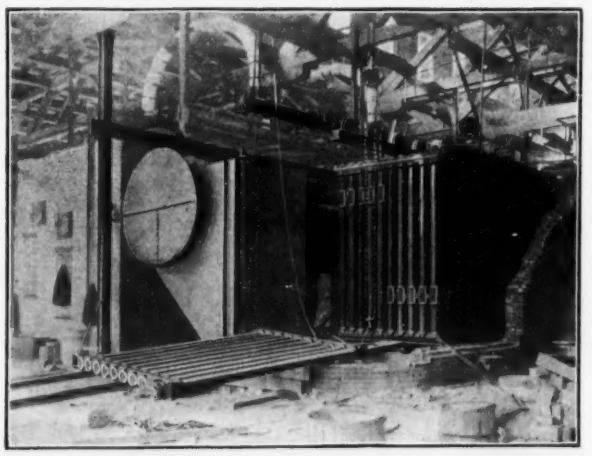

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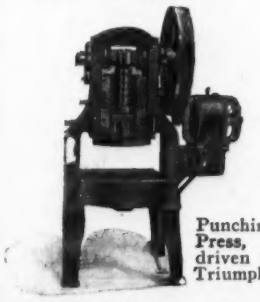

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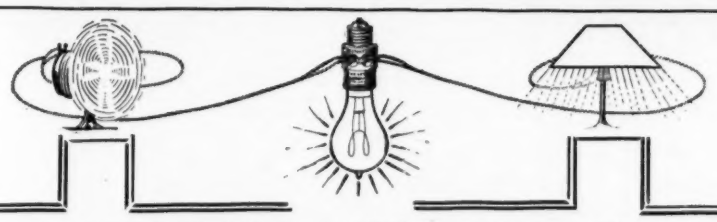

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